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## Electronic Data Interchange (EDI)

Using Electronic Commerce  
to Enhance Defense Logistics

Judith E. Payne, Robert H. Anderson

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Judith E. Payne, Robert H. Anderson

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Assistant Secretary of Defense  
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## PREFACE

Electronic data interchange (EDI) is a step toward "electronic commerce"—an application of computer technology that promises to enhance the nation's productivity by moving both private and public sector business from a paper-based world to one based solely on electronic transactions. Simply stated, EDI is the electronic exchange of formatted business transactions between one organization's computer and another's.

In May 1988, the Deputy Secretary of Defense issued a policy directive that EDI was to become the "way of doing business" for the Department of Defense (DoD). The question for defense components thus became not whether to use EDI but rather where and how to implement it first. Where should DoD focus its limited resources to implement this powerful new capability in order to enhance its effectiveness? And how must logistics functions change to take full advantage of EDI? The study summarized in this report addresses these questions, focusing on the use of EDI for logistics functions that could increase the readiness and sustainability of U.S. defense forces. It also suggests ways in which statutes and regulations might need to change to accommodate EDI's potential benefits and offers approaches that DoD might take to develop a software and hardware infrastructure to support EDI.

The results of this study will be useful to senior policymakers directing EDI efforts as well as to managers who are directly implementing EDI; the latter will find guidance regarding the ways in which current policies and regulations permit or restrict such efforts.

This project was carried out within the Acquisition and Support Policy Program of RAND's National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense and the Joint Chiefs of Staff. The study was sponsored by the Assistant Secretary of Defense (Production and Logistics).

## SUMMARY

Electronic data interchange (EDI) has been advocated as one of the most important applications of computer technology, and one that holds the greatest potential for improving the nation's productivity—for with EDI will come “electronic commerce,” a technology that will allow both private and public sector business to move from a paper-based world to one based solely on electronic transactions. Each EDI transaction is formatted in such a way that it can be recognized and processed by a firm's computer without human intervention—that is to say, without the need for a person to interpret the transaction for the computer. Even more important, EDI enables businesses as well as DoD to use many new techniques in pursuit of more effective resource management.

The use of EDI in the private sector has steadily increased since its introduction in the transportation industry in the late 1960s. Defense components (i.e., services and defense agencies such as the Defense Logistics Agency) have also begun to use EDI in dozens of efforts. This trend culminated in May 1988, when the Deputy Secretary of Defense issued a policy directive that EDI was to become the “way of doing business” for the Department of Defense (DoD) in the future. The question for defense components thus became not whether to use EDI but where and how to implement it first. The implementation of any new technology application, however, is a difficult and often costly process—even when that technology is well developed and its infrastructure is fully in place. Where, then, should DoD direct its limited resources to enhance its effectiveness?

To help coordinate the EDI effort and lay the groundwork for its success, in 1988, the Office of the Assistant Secretary of Defense, Production and Logistics, established an EDI users' group with representatives from each defense component. The study summarized in this report is intended to assist this group as well as the individual defense components in their efforts to answer these questions:

- Which uses of EDI will best enhance the logistics process?
- What impediments stand in the way of these enhancements?
- How should DoD direct its resources to promote EDI?
- More generally, what must be done to create a legal and institutional environment that is conducive to EDI?
- How should DoD move toward its implementation?

## FIVE TARGET AREAS FOR EDI TO ENHANCE LOGISTICS

Our analysis indicates that EDI can directly or indirectly improve logistics processes in the following ways:

1. By shortening procurement administrative lead time (PALT), including presolicitation, solicitation, and award time (especially for contract actions under \$25,000) and order placements against approved contracts of any size.
2. By broadening and hastening access to the industrial base, thereby enhancing procurement responsiveness—especially in areas where sources are hard to find and where untapped private sources may exist.
3. By allowing for tighter and more dynamic control over vendor performance—e.g., in monitoring the timely shipment of purchased goods from vendor sites; circumventing congestion in transportation pipelines or at transportation nodes; and dynamically prioritizing contractor weapon system repair. This target parallels the retail industry's use of EDI in "quick response" systems, which link retailers to their suppliers in such a way that stock is replenished in "floor-ready" units on the basis of actual retail sales.
4. By providing short-term, accurate "heads up" (advance notice) to logistics pipeline actors both within and outside DoD—most notably by improving the management of DoD receiving points and by providing item managers with data on the status of assets at contract repair facilities.
5. By allowing for better responses to unpredictable surges in demand for critical goods or services through the design of EDI systems that can shift to a different set of operational protocols during a crisis.

If EDI is used in these ways, numerous indirect benefits may also be derived. As PALT decreases, for example, DoD will not have to anticipate its needs so far in advance, and its buying decisions can thus be deferred to a time that more closely approaches when items are actually needed—thereby reducing needed stockage levels *and* excess stocks engendered by inevitable errors in demand projection. EDI can also improve DoD's ability to meet its statutory mandate for competitive procurements *and* make it simpler and less costly to do so. Finally, EDI can improve small businesses' access to DoD business and make the administrative side of such business less time-

consuming, thereby "leveling the playing field" between small and large concerns.

### **WHY POTENTIAL GAINS HAVE NOT YET BEEN REALIZED**

Despite the numerous applications of EDI that DoD has implemented, few actual gains from EDI can be cited in the above target areas. These potential gains have not been realized for five critical reasons. First, most initial DoD efforts to use EDI have focused on improvements that do not affect the logistics pipeline or have been confined to proving the technical feasibility of EDI, while others are simply not far along. Second, even where EDI has been used in logistics target areas, it has not been fully exploited as a tool to perform work differently, and has not been designed and implemented to achieve its full potential gains in the target areas. Third, links between DoD's EDI applications and the logistics systems of both DoD and vendors are weak. Fourth, current DoD EDI efforts are hampered by uncertainty regarding the impact of EDI on small businesses and competition as well as by ambiguity surrounding the legal and regulatory status of electronic business transactions. Finally, standards, software, and network approaches are incomplete and tend to reflect paper-based methods.

### **WHAT NEEDS TO BE DONE WITHIN DoD**

In the final analysis, the full benefits of EDI for defense logistics will not come simply through the use of electronic transactions—i.e., through the substitution of an electronic transaction for a paper one or for a phone call. If only that is done, DoD may find, as some private sector users have discovered, that EDI reaps net costs, not net benefits. Several other conditions must be met.

First, EDI efforts should concentrate on those transactions that are most amenable to EDI—i.e., transactions dealing with well-defined or clearly identifiable items or services; simpler procurements under \$25,000; and orders against preexisting contracts above or below \$25,000.

Second, DoD should focus its efforts on areas in which EDI can best contribute to the resolution of important problems—not those in which it will upgrade processes that warrant little improvement. This will vary across commodities, defense services, and buying points—but overall, emphasis should be placed on commodities for

which demands are unpredictable, surges are likely in contingencies, and timeliness is especially critical. Efforts should also focus on the shortening of pipeline segments in which external organizations play an integral role and on making such segments more dynamically controllable.

DoD's business practices and internal automated logistics information systems must also change if they are to fully exploit EDI. But it will not be sufficient simply to build electronic interfaces to generate and accept EDI transactions. Instead, a variety of electronic "tools" must be developed or refined that will automate DoD-vendor transactions as much as possible. These tools now exist in varying forms of sophistication both within and outside of DoD, although some now operate with only semiframed electronic transactions. They are:

- Electronic brokers that create marketplaces where buyers and sellers can conduct business;
- Electronic broadcast mechanisms where buyers broadcast demands to potential sellers and sellers can broadcast "specials";
- Electronic bulletin board systems where buyers post demands that sellers can offer to meet and where sellers can post resources available and "specials";
- Interorganizational electronic databases that can provide cross-vendor stock availability or track the status of transactions; and
- Electronic agents that are computer programs for screening information, making queries, and the like.

As with any new information technology, EDI's anticipated benefits cannot be taken for granted once an EDI application has been implemented. Instead, that application must be designed, implemented, and monitored to ensure that such benefits are fully realized; tasks, procedures, and even policies are changed where needed; unexpected benefits, unwanted effects, and costs are appropriately identified and addressed; and the application itself is adjusted where necessary. Toward these goals, DoD users and suppliers must be asked for feedback on how the application works—e.g., what works well, what works poorly, and what needs to change.

## AN ENVIRONMENT TO PROMOTE ELECTRONIC COMMERCE

DoD can make some progress in addressing these issues within current regulations and statutes. But for electronic commerce to become DoD's standard way of conducting business, several laws and regulations must be revised or reinterpreted. The Federal Acquisition Regulation (FAR) will require revisions that recognize electronic transactions and define the conditions under which such transactions can be used both for contractual commitments and as source documents for accounting transactions. The Walsh-Healey Act, which governs a firm's eligibility to do business with DoD, will need clarification as well, along with possible reinterpretation. With changes such as these, electronic commerce can allow DoD to *better* meet the intent of the FAR to support full and open competition among interested and qualified vendors as well as to encourage small-business involvement.

The transition to EDI will also necessitate changes in the operations of DoD vendors. Many vendors, for example, will need to acquire equipment to fully adapt their DoD transactions to electronic commerce. For most firms, the costs associated with such changes will be relatively modest and can be spread over many business uses. For a minority of vendors, however, the requirement to deal with DoD electronically may constitute a financial burden—and one that may appear unreasonable until electronic commerce is more widely used in the private sector. DoD can alleviate this burden in several ways—e.g., by working with the Small Business Administration and with other organizations to demonstrate to small businesses how EDI may be used for their own gains.

In like manner, transaction standards, translation software, and telecommunications networks used to implement EDI DoD-wide must render the industrial base accessible to DoD *and* make DoD buying, shipping, receiving, and inventory control points accessible to vendors. This accessibility must, however, be tempered by the need to secure classified information and vendors' proprietary information as well as unclassified but sensitive defense information. Safeguards must especially be established to guard sensitive but not classified data as well as to guard against the threat of "traffic analysis"—that is, information that can be derived from transaction patterns and volumes alone. No one solution to security risks will suffice for all EDI transactions; solutions such as encryption techniques alone are insufficient.

Finally, DoD's approach to EDI must protect the integrity of EDI transactions by meeting standard auditing and accounting objectives.

#### **NEXT STEPS TOWARD IMPLEMENTING EDI**

If logistics gains are to be achieved from EDI, a software and network environment must be developed. Summarized below are suggested steps that are essential to the development of an EDI environment.

**Establish Electronic Mail Addresses for All DoD Procurement Offices and Suppliers.** Before each DoD office or agency involved in logistics establishes its own procedures for communicating with its suppliers, the Defense Logistics Agency, as executive agent for DoD EDI, should take prompt, active steps to centralize these activities. This requires three separate thrusts: establishing an electronic address for each relevant DoD procurement office; identifying electronic-mail addresses for any supplier that has one; and establishing electronic mailboxes (and hence addresses) on a DoD wide-area network for those suppliers that lack mailboxes.

**Establish a System of Bulletin Boards for DoD Use, Secured Appropriately.** Decisions must be made regarding the types of data and transactions that can be placed on bulletin boards. Security concerns regarding the possible creation of sensitive but not classified data need to be addressed in light of the ease with which such data can be analyzed in aggregate.

**Make EDI Network Security a Top Priority.** A blueprint for creating policies, regulations, and verification and validation mechanisms for checking security must be developed before EDI becomes the standard means of performing logistics transactions. This is a critical task whose magnitude cannot be underestimated. Attention should also be focused on the increasing globalization of the economy upon which DoD depends and on the need to bring regulations involving the export of cryptographic devices in line with this socioeconomic reality.

**Obtain Authority and Judicial Verification for Use of Electronic Signatures.** Appropriate combinations of encryption and authentication mechanisms permit as much verification and trust of electronic signatures as we currently have for "wet" (inked) ones. A planned government project to develop a generic signature and authentication module for use throughout the federal government would appear to be an important step toward this goal.

### **Establish a Cutover Date to Electronic EDI Transactions.**

Although the expense and burden of a dual paper/electronic system for handling DoD business transactions should be minimized by transition to a purely electronic system at the earliest practicable time, many obstacles must be overcome before such a transition can be made. Specifically, the success of DoD EDI efforts hinges on the implementation of the MODELS (MODernization of DEFense Logistics Standard Systems) program, which should be in place by 1992 or 1993. Allowing sufficient time for network gateway and format translation developments and addressing the security, privacy, and integrity concerns discussed above, we believe it is reasonable to assume that by 1996, EDI transactions will be the sole means by which routine DoD procurements are conducted. We reiterate, however, that the achievement of full reliance on EDI for DoD procurement transactions is a formidable engineering, policy, and legal task. Hence, if a 1996 target date is to be met, the roadblocks discussed here must be addressed through the application of strong, effective leadership and substantial resources.

The recent establishment of the Defense Logistics Agency (DLA) as the DoD executive agent for EDI is an important first step toward implementation of EDI technology. In this role, DLA should work with the Office of the Secretary of Defense to:

- Ensure that needed changes to laws and regulations are made;
- Coordinate the maturity and extension of the many EDI applications now being developed;
- Point the direction for the development of other EDI applications in target areas and the nascent software and hardware infrastructure for electronic commerce; and
- Impose and enforce network and software standards following EDI implementation guides.

DLA should also lead DoD's involvement in the EDI transaction standard development process both in the United States and internationally as it affects DoD, and it should also participate in developing—or encourage the development of—innovative electronic marketplace tools that enable DoD to travel, within the bounds defined by security concerns, the emerging “electronic highway” of commerce.

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## GLOSSARY

AAR	Association of American Railroads
ABA	American Bar Association
Agent	A set of computer programs working with EDI transactions in their owner's interest
AIAG	Automotive Industry Action Group
ALC	Air Logistics Center (Air Force)
ALT	Administrative Lead Time
AMIS	Acquisition Management Information System (Air Force)
ANSI	American National Standards Institute
APADE	Automation of Procurement and Accounting Data Entry (Navy Information System)
ASO	Aviation Supply Office (Navy ICP)
ATA	Air Transport Association
AUTODIN	Automatic Digital Network, a private DoD wide-area network for data
AUTOVON	Automatic Voice Network, a private DoD wide-area network for voice
BCAS	Base Contracting Automated System (Air Force)
BidNet	A private, electronic bidders' service with local, state, and federal government solicitation information
BOA	Basic Ordering Agreement
Broadcast system	An electronic system where buyers broadcast demands to potential sellers and sellers can broadcast "specials"
Broker	An electronic system that creates a marketplace where buyers and sellers can conduct business
Bulletin board	An electronic system where buyers post demands that sellers can offer to meet and sellers can post resources available and "specials"
CAGE	Contractor and Government Entity [Codes]
CALS	Computer-Aided Acquisition and Logistic Support
CBD	Commerce Business Daily

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CCITT	Consultative Committee for International Telegraph and Telephone: the organization that establishes recommendations for international communications standards
CDMS	Contract Data Management System (Air Force)
CONUS	Continental United States
DAAS	Defense Automatic Addressing System
DAASO	Defense Automatic Addressing System Office
DARPA	Defense Advanced Research Projects Agency
DCSC	DLA Defense Construction Supply Center
DDN	Defense Data Network, a private DoD data WAN
DES	Data Encryption Standard
DESC	DLA Defense Electronics Supply Center
DFARS	DoD FAR Supplement
DGSC	DLA Defense General Supply Center
DINET	Defense Industrial Network
DISC	DLA Defense Industrial Supply Center
DLA	Defense Logistics Agency
DLSS	Defense Logistics Standards System
DoD	Department of Defense
DPACS	DLA Preaward Contracting System
DPSC	DLA Defense Personnel Support Center
DRIVE	Distribution and Repair in Variable Environments, an Air Force prototype system
EASE	Electronically Assisted Solicitation Exchange
EDI	Electronic Data Interchange
EDIA	Electronic Data Interchange Association
EDIFACT	An emerging international standard for EDI
EFT	Electronic Funds Transfer
Email	Electronic mail
ERS	Evaluated Receipts Settlement
FAA	Federal Aviation Administration
FAR	Federal Acquisition Regulation
FAST	An electronic broker prototype for standard electronic parts at USC Information Sciences Institute
FAX	Facsimile
FIPS	Federal Information Processing Standards
FLSA	Fair Labor Standards Act (federal)
FSC	Federal Supply Class
FSS	Federal Supply Schedule

FTS2000	A major Federal Telecommunications System procurement, encompassing both voice and data wide-area services
Gateway	A node in an electronic network providing a connection between two networks
GBL	Government Bill of Lading
GSA	General Services Administration
ICP	Inventory Control Point, same as NICP
IDC	Indefinite-Delivery Contract as defined in FAR 16.5
IGP	Intelligent Gateway Processor, being developed at Lawrence Livermore National Laboratory
ILS	Inventory Locator Service (private, for-profit cross-vendor database for aircraft parts and repair services)
IM	Item Manager
IPS	Integrated Procurement System (Army)
LAN	Local area network: a network of computers within a building or other close geographical area not exceeding the diameter of several kilometers
LLNL	Lawrence Livermore National Laboratory
LMI	Logistics Management Institute, Bethesda, Maryland
MAGIC	Manufacturers and Government Interconnected by Computer, an Air Force project
MCLB	Marine Corps Logistics Base (in Albany, Georgia)
MILSTEP	Military Supply and Transportation Evaluation Procedures
MODELS	MODernization of DEFense Logistics Standard Systems
MTMC	Military Traffic Management Command
MUFFIN	GSA's Multi-Use File for Inter-Agency News
NARA	National Archives and Records Administration
NICP	National Inventory Control Point, same as ICP
NIST	National Institute for Systems and Technology
NSA	National Security Agency
NSC	Naval Supply Center
NSN	Department of Defense National Stock Number
NTIS	National Technical Information Service
OASD	Office of the Assistant Secretary of Defense
OFPP	Office of Federal Procurement Policy

ONE	Orion Network Enterprises, an AutoInfo Company, Omaha, Nebraska
OSD	Office of the Secretary of Defense
PALT	Procurement Administrative Lead Time
PASS	Procurement Automated Source System
PCLT	Procurement Lead Time
PKE	Public Key Encryption
PLT	Production Lead Time
PLUS	Protection of Logistics' Unclassified/Sensitive Systems
POPS	Paperless Ordering Placement System (DLA)
RAILINC	A wholly owned subsidiary of the Association of American Railroads (AAR)
RFB	Request for Bid
RFP	Request for Proposal
RFQ	Request for Quote
SAACONS	Standard Army Automated Contracting System
SAMMS	Standard Automated Material Management System (DLA)
SAMMS-DPACS	SAMMS-DLA Preaward Contracting System
SBA	Small Business Administration
SIC	Standard Industrial Class
SPEDE	SAMMS Procurement by Electronic Data Exchange
STLSS	Shipments to Line Set Sequence
TCP/IP	Transmission Control Protocol/Internet Protocol
TDCC	Transportation Data Coordinating Committee, now EDIA
TMO	Transportation Management Office
TPG	Transportation Priority Group
TRAIN II	TeleRail Automated Information Network
UNCID	Uniform Rules of Conduct for Interchange of Trade Data by Teletransmission
USTRANSCOM	U.S. Transportation Command (DoD)
VAN	Value-Added Network: a WAN providing value-added services
WAN	Wide Area Network: a network of computers that typically spans entire states or even countries
X12	ANSI standard transaction formats for EDI
X.400	CCITT standard for electronic mail interchange
X.500	CCITT standard for electronic directory of electronic mail addresses

## I. INTRODUCTION

Electronic data interchange (EDI) is a significant step toward the institution of "electronic commerce," an application of computer technology that promises to enhance the nation's productivity by moving both private and public sector business from a paper-based domain to one that is based solely on electronic transactions.<sup>1</sup> Simply stated, EDI is the electronic exchange of formatted business transactions between one organization's computer and another's. For example, one firm might send a purchase order to another firm electronically, and the recipient firm might then return an electronic shipment notice or invoice. EDI transactions are formatted so that a firm's computer can recognize and process them without human intervention—i.e., so that no person need interpret the transaction for the computer. Several industries and a cross-industry association, the American National Standards Institute (ANSI), have already developed standard formats that facilitate various EDI transactions between many firms.

The use of EDI in the private sector has been steadily increasing since the transportation industry led the way into EDI in the late 1960s. By 1989, 17 percent of business managers reported that they were currently using EDI, with an additional 5 percent planning to implement EDI within 1989 and a total of 52 percent reporting that they already used EDI or planned to do so within the next two years.<sup>2</sup> According to one estimate, over 7,000 North American firms in a wide variety of industries now use EDI.<sup>3</sup>

Defense components<sup>4</sup> have also begun to use EDI in dozens of applications, from electronic order placement and payment to status reporting of Department of Defense (DoD) shipments by private carriers. This trend culminated in May 1988, when the Deputy Secretary of Defense issued a policy directive that EDI was to become the "way of doing business" for DoD. The question for defense components thus became not whether to use EDI but rather where and how to implement it first. Implementing any new technology, however, is a difficult and often costly process even when that technology is well developed and its infrastructure is fully in place. Where, then, should DoD

<sup>1</sup>See, for example, Sutherland, 1975, and Cohen, 1989.

<sup>2</sup>Masson and Hill, 1989, p. 16.

<sup>3</sup>TDCC, 1989, p. v.

<sup>4</sup>Defense components include Department of Defense services and agencies such as the Defense Logistics Agency.

direct its limited resources in its efforts to enhance EDI's effectiveness?

To help coordinate the EDI effort and lay the groundwork for its success, the Office of the Assistant Secretary of Defense, Production and Logistics, established an EDI user group with representatives from each defense component. The RAND Corporation was directed to assist this group as well as the individual defense components in their efforts to answer the following questions:

- What uses of EDI can best enhance the logistics process?
- How might the logistics process itself change to take advantage of EDI?
- What current policies and procedures appear to present obstacles to the achievement of the potential benefits of EDI in defense logistics?
- How should DoD approach EDI software development and network support?

In the paragraphs that follow, we will provide a more detailed definition of EDI, explain the current study's focus on the logistics process, and outline the remaining sections of this report.

## DEFINING EDI

As defined by private industry and ANSI, EDI is a technique by means of which formatted, transactional information is moved electronically from one organization's computer to another's. In EDI processes, transactions are sent and received in electronic form rather than verbally or on paper. Three aspects of this definition warrant further elaboration: "transactions," "formatted," and "between organizations."<sup>5</sup>

**"Transactions."** By "transactions," we mean the great variety of information exchanges related to conducting business between two autonomous organizations. Organizations buy and sell goods and services from each other and, in doing so, solicit bids, make awards, offer various terms (e.g., delivery times), submit invoices, and receive payments. But business transactions to support this simple buy-sell relationship can become fairly complicated. For example, firms sometimes share short- or long-term plans and schedules for future

<sup>5</sup>For more detailed definitions of EDI and discussions of various formats, refer to Hinge, 1988, and American National Standards Institute, 1987.

transactions, adjust transactions, and monitor the status of the goods or services they have bought (e.g., to determine whether they are on schedule or back ordered). Hence, transactions can include a wide variety of information exchanges.

**"Formatted Transactions."** EDI transactions are formatted so that a computer can be programmed to recognize and handle them without any human intervention. Hence, unformatted text sent as electronic messages is not considered to constitute EDI transactions because a human must read them and then decide how to handle them. For example, a firm might send an electronic order for light bulbs in two ways, one EDI and the other not. If the firm sends an electronic message to a bulb manufacturer saying, "Please send us a case of 100-watt light bulbs by next Wednesday in accordance with our contract with you," the order would be received electronically but would be read by a person and would thus be considered electronic mail in text form, not EDI. The order would, however, be EDI if it were sent in accordance with a prearranged format so that the bulb manufacturer's computer could read it directly—i.e., with set characters separating predefined fields such as the number of cases, the item ordered, and the delivery date.

Certainly, text electronic mail ("email") communications between DoD and external organizations is useful and will likely be an essential capability complementing the use of EDI, and the line between EDI formatted exchanges and text email will blur as computers become increasingly able to parse (i.e., read) natural language. For the near future, however, the distinction still stands, and the focus of this study is on the use of EDI, not text email.

The use of standard formats for EDI transactions is especially vital for firms that seek to exchange transactions with most if not all of their trading partners in a consistent manner. Standard formats for EDI transactions, however, can be proprietary or public. By directive, DoD EDI must evolve toward the use of publicly available formats defined by ANSI or by other widely accepted, industry-defined standards, such as the international, U.N.-sponsored process referred to as EDIFACT. EDI formats and related national and international standards for exchanging such transactions are discussed in more detail in Section IV of this report.

EDI formats may incorporate information defined by other standards; for example, an EDI transaction for ordering a repair part might include a field describing the part's engineering specifications. For DoD transactions, these specifications will eventually be formatted in accordance with standards for electronic description of engi-

neering specifications for weapon systems developed in Computer-Aided Acquisition and Logistics Support (CALS), a related DoD project.<sup>6</sup>

**"Between Organizations."** Internally, DoD and other organizations have been handling transactional information in electronic formats for years. For example, DoD components pass electronic requisitions from end users to intermediate and wholesale supply levels in accordance with standard electronic military formats. The formats of such transactions are now being revised in the Modernization of Defense Logistics Standard Systems (MODELS) project.<sup>7</sup> Although much of the same information in these internal DoD transactions is included in external EDI transactions, MODELS transactions are not considered EDI because they are internal to the defense components.<sup>8</sup>

EDI can similarly be seen as a simple extension of long-established internal business systems (e.g., a material management system or a requisitioning system) to a firm's suppliers or customers. Sometimes, for example, a firm must buy an item to fill an internal requisition, thereby triggering a transaction with another firm. If that requisition is in electronic form, it is a fairly easy step to construct an electronic purchase order to send to a supplier. But the challenge of EDI to DoD and private firms is in the autonomy of the two parties exchanging transactions electronically. New transactions are involved (e.g., a firm might not actually "buy" and "sell" internally); formats must be agreed upon; and contractual agreements must be changed and new rules made. Extending electronic transactions beyond an organization's bounds also imposes new costs in exchange for its benefits.

This distinction between internal and external transactions must remain clear if DoD is to address the new opportunities, costs, and

<sup>6</sup>Computer-Aided Acquisition and Logistics Support (CALS) is an Office of the Secretary of Defense initiative to develop a strategy to keep technical information in digital form throughout the life cycle of a weapon system. The CALS program began in September 1985 as an industry-DoD effort. The implications of CALS for DoD's use of EDI is discussed in more detail in Section V of this report.

<sup>7</sup>The MODELS project was initiated in 1984 by the Office of the Secretary of Defense to modernize the Defense Logistics Standards System (DLSS). The DLSS has been used by the defense components since 1962 to exchange in standard electronic formats a variety of logistics-related transactions. The formats are now being revised and enhanced with a syntax similar to that of the ANSI X12 EDI transaction standards. See Defense Logistics Standards System Office (DLSSO), undated.

<sup>8</sup>There are minor exceptions to this. For example, a major contractor may requisition government-furnished materials from DoD stock using a DLSS transaction generally used only within DoD. (This transaction is not treated exactly like an internal one despite the common format.)

obstacles associated with each. EDI moves electronic transaction processing into new territory, and, as with any new technology, there is an inherent danger that EDI will be directed away from areas in which greater gains in overall effectiveness might be achieved—e.g., in internal MODELS-related logistics tasks. To avert this “technology push” problem, each of our analyses of EDI-enabled enhancements to the logistics process begins with the entire logistics pipeline both internal and external to DoD. With this approach, the relative importance of EDI gains can remain in perspective.

### FOCUS ON LOGISTICS FUNCTIONS

EDI can be used in a variety of DoD activities, all of which can benefit DoD—from paying vendors to exchanging information with vendors in compliance with various regulations.<sup>9</sup> One study estimated that DoD could achieve \$1.2 billion cost savings over 10 years with an investment of \$80 million by simply replacing with electronic forms its 16 most common transaction documents.<sup>10</sup> Such applications may also indirectly enhance logistics by producing significant savings, which could in turn be expended on the improvement of logistics functions. Such nonlogistical uses of EDI are addressed in this study only to the extent that they affect the logistics pipeline.<sup>11</sup>

The research summarized in this report limited its scope to the potential use of EDI in logistics for two reasons. First, many logistics activities in transportation, maintenance and repair, supply, and procurement involve transactions with non-DoD organizations—transactions that are all potentially affected by EDI. Second, the mission of logistics is to support the user in the field with what is needed when, where, and in the condition and quantity required at the minimum expenditure of resources. Hence, logistics activities can directly affect the readiness and sustainability of defense forces during a contingency or war.

To be responsive, logistics activities must meet uncertain demands and sudden surges in demand under changing conditions.<sup>12</sup> Defense

<sup>9</sup>See, for example, Heard and Bridges, 1988, which recommends that DoD implement electronic invoicing with motor carriers in order to reduce clerical work, with projected savings of 114 out of 700 personnel positions at the U.S. Army Finance and Accounting Center.

<sup>10</sup>Hardcastle and Heard, 1990, p. iii.

<sup>11</sup>See, for example, target two in Section III.

<sup>12</sup>For an assessment of the uncertainty of wartime demands, see, for example, Crawford, 1988. This study demonstrates the unpredictability of aircraft weapon sys-

logisticians can (and do) employ a variety of responsive techniques to cope with this uncertainty. Such strategies include obtaining more current information to reduce the need to forecast; using resources flexibly (and flexible resources); pushing the risks onto someone else, and operating on a larger scale.<sup>13</sup> Given these strategies, the optimum logistics pipeline between a user's demand and its fulfillment is short, flexible, and accurate. Accordingly, this study examines the ways in which EDI could contribute to these adaptive strategies to enhance the logistics pipeline.

### SOME REQUISITE ELECTRONIC TOOLS

If EDI is to achieve its potential, it must be coupled with the use of a range of electronic "tools." Five such tools, all of which can be enabled or improved by EDI, are introduced here to serve as background to the rest of this report. These tools, which now exist in varying forms of sophistication within and outside DoD, have been identified as prerequisites to some of the potential gains described in Section III and, if designed well, can fully exploit the electronic formats of EDI transactions. They are:

- Electronic brokers;
- Electronic broadcast mechanisms;
- Electronic bulletin board systems;
- Interorganizational electronic databases; and
- Electronic agents.

Table 1.1 provides brief descriptions of these tools, all but the last of which operate within an "electronic marketplace" with electronic, formatted transactions from several sources at once. As such, all four tools can operate independently either as neutral market facilitators or in the interests of groups of buyers (e.g., DoD components) or

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tem failures even during peacetime, which in turn place unpredictable demands on the repair, supply, procurement, and transportation logistics functions.

<sup>13</sup>See Hodges and Pyles, 1989, for a discussion of these and other adaptive strategies.

Table 1.1  
SOME EDI GAINS DEPEND ON ELECTRONIC TOOLS

Electronic Tool	Description
Broker	Creates a market where buyers and sellers can conduct business.
Broadcast system	Buyers broadcast demands to potential sellers. Sellers broadcast "specials."
Bulletin board system	Buyers post demands that sellers can opt to propose to meet. Sellers can post resources available, "specials."
Interorganizational database	Can provide cross-vendor stock availability and track records and status data.
Agent	Computer programs working with EDI transactions in their owner's interest.

sellers. In this way, they can speed the match of buyers and sellers; reduce the costs of competition; increase competition, which may lead to reduced prices; or allow sellers to identify new prospective buyers or markets to enter.<sup>14</sup> Hence they can hasten and improve DoD's access to various marketplaces as well as vendors' access to DoD, as will be discussed in Section III. All of these tools have been available in varying forms prior to EDI. With EDI, however, they can be used in new marketplaces or in new ways.<sup>15</sup>

### Electronic Brokers

An electronic broker creates or enhances a marketplace by linking buyers and sellers. The various cross-airline reservations systems can be seen as examples of electronic brokers that match travelers' demands with airplane seats.<sup>16</sup> Similarly, FAST,<sup>17</sup> a DARPA-funded

<sup>14</sup>See Malone et al., 1987 and 1989, for related discussions on the effects of EDI and new electronic tools on markets.

<sup>15</sup>These tools can also be used within DoD to facilitate internal markets—e.g., by matching sources of surplus supplies with prospective users. Because such uses are internal to DoD and do not involve EDI, they are not discussed in this report.

<sup>16</sup>See Copeland and Mckenney, 1988, for a description of their evolution and Cash, 1985, for further discussion of the Civil Aeronautics Board's report on such systems and Frontier Airlines' allegations of unfair competitive advantage by United Airlines in the design and use of its system.

<sup>17</sup>A research project of the Information Sciences Institute (ISI), University of Southern California, Marina del Rey, California.

project, is a prototype electronic broker for DoD and non-DoD buyers and sellers of standard electronic parts. Buyers can electronically ask FAST for quotes and availability of components. FAST then queries suppliers, electronically where possible; provides buyers with quotes and availability data; and subsequently transmits awards (orders) back to suppliers. Buyers can also provide FAST criteria to make awards for them—e.g., within certain price and delivery parameters. FAST is invoiced by the sellers and, in turn, invoices the buyers.

### **Electronic Broadcast Systems**

On an electronic broadcast system, buyers broadcast their demands electronically via an electronic network or satellite to unidentified sellers, who then electronically receive and screen broadcasts, responding only to relevant ones. Automotive dismantlers and recyclers in the salvage industry use electronic broadcast systems of various types to match prospective buyers of hard-to-find parts, often relying on such systems to afford them access to their dispersed marketplace. Orion Network Enterprises,<sup>18</sup> a nationwide broker that broadcasts via satellite, claims that over 1,300 salvage yards in the United States and Canada exchange 15,000 to 25,000 electronic transactions daily, with each yard featuring a personal computer and a satellite dish to receive broadcasts. Currently, most of these electronic transactions are unformatted text, with prospective sellers and buyers exchanging bids and agreeing on orders in electronic text messages following the broadcasts. Formats now being introduced, however, would enable yards to electronically link broadcasts to their internal inventory systems so that formatted requests could be electronically matched against available stock.

### **Bulletin Board Systems**

Electronic bulletin board systems are similar to broadcast systems in their operation, except that requests are located together for suppliers and buyers to browse. Bulletin boards vary greatly in their sophistication and capabilities. If transactions are highly formatted (as are EDI transactions) and in a structured database, they can be browsed electronically more easily. If they include enough detailed

<sup>18</sup>Orion Network Enterprises (ONE), AutoInfo Company, is located in Omaha, Nebraska.

data, suppliers can respond without having to request hard-copy documents. They can also be linked to systems allowing sellers to send EDI responses to requests posted.

Naval Supply Center (NSC) Jacksonville is now implementing a bulletin board-type system called EASE (Electronically Assisted Solicitation Exchange) for small local procurements. In this system, requests for quotes (RFQs) are posted on an electronic bulletin board located on a commercial electronic network service. Any user of that network can browse through the RFQs using simple search parameters and can then download those that are of interest, but only pre-screened vendors can actually submit quotes electronically. EASE was designed for people to use, not for their computers to query automatically, and RFQs do not conform to any EDI standard—but interested firms can, with some effort, program their own computers to scan bulletin board entries automatically and download those of interest.

Various other DoD buying points, including the Defense Construction Supply Center (DCSC), operate bulletin boards on which they post some information for certain RFQs, but these do not yet allow vendors to respond electronically.

Several private vendors operate bulletin board systems or quasi-bulletin boards listing government invitations to bid or propose from Commerce Business Daily (CBD) and other government sources. At least one, BidNet,<sup>19</sup> combines such information from some 1,800 federal, state, and local governments, making it a cross-seller and cross-buyer bulletin board system.

### Interorganizational Databases

Vendor data in EDI formats can be combined in interorganizational databases for buyers (and sellers) to query. Inventory Locator Service (ILS),<sup>20</sup> for example, offers subscribers access to a database of the inventories and overhaul capabilities of over 1,200 new, used, and excess aircraft parts suppliers.<sup>21</sup> Some 1,700 subscribers to ILS in the aviation industry, including dozens of DoD users, make 10,000 to 15,000 electronic queries to the system each day in efforts to find

<sup>19</sup>A company of the Dun & Bradstreet Corporation.

<sup>20</sup>Inventory Locator Service, Inc., Ryder System Company, Memphis, Tennessee.

<sup>21</sup>The Air Transport Association (ATA) operates a somewhat similar cross-vendor database system targeted at 50 to 60 large commercial airlines. The system is called AIRS (Airline Inventory Redistribution System). It is also developing a more advanced electronically formatted system called SPEC2000 allowing order placement.

suppliers that have the parts they seek or to identify acceptable substitutes. Buyers can automatically generate electronic RFQs to vendors showing stock availability. The ILS database carries stock availability data on nearly six million unique part numbers and is linked with a DoD National Stock Number (NSN) cross-reference to manufacturers' part numbers and procurement history databases, purchased from DoD contracting offices.<sup>22,23</sup> Most users of the ILS database, however, do not electronically link the system directly to their internal computers; instead, a human performs the queries.

A nonprocurement example of an electronic interorganizational database is that operated by RAILINC, a wholly owned subsidiary of the Association of American Railroads (AAR). TRAIN II (TeleRail Automated Information Network) combines information on freight car movements from 68 railroads. Carriers, freight forwarders, and shippers can electronically query the system for car locations and routing information across railroads.

### Electronic Agents

No matter what its form, electronic or hard copy, information is not useful until it is placed in a format that can be used—i.e., managed, verified, and acted on. We use the term “electronic agents” to refer to computer programs that are created to work with EDI transactions in their owner's interests to (1) screen information; (2) make queries; (3) analyze and summarize trends (e.g., competition or prices); or (4) alert the owner to exceptions. Electronic agents can be conventional computer programs, or they can incorporate expert-system techniques.

Various private sector bidders' services today function as agents for government vendors. Some use electronic agents to screen electronic files of government requests for bids or quotes or even intents to solicit and deliver bidding information to vendors. Similar electronic agents could screen EDI requests for quotes for vendors to identify those to bid on. The Orion broadcast system for salvage yards, cited above, incorporates “electronic agents” that automatically screen

<sup>22</sup>The ILS database includes over 14 million stock locations of these parts at different vendors.

<sup>23</sup>Several other firms provide similar cross-reference services. They are not considered EDI or quasi-EDI by this study because they do not relate directly to a business transaction.

broadcast messages for each user. The agents work with parameters set by each yard to sort out and save only those broadcasted requests for the types and makes of vehicles, and in the geographic area, that the yard supports.

## **ORGANIZATION OF THIS REPORT**

In the following sections, we discuss our research approach and the results of our study. Section II summarizes our approach. Section III describes five key target uses of EDI in four logistics functions. Section IV assesses why the potential gains of EDI have yet to be realized and includes a discussion of regulatory and statutory obstacles to EDI's use. In Section V, we discuss the network and software infrastructure that is needed to apply EDI to defense logistics; included are a discussion of the objectives for its design and configuration, an approach to meeting these objectives, the estimated costs of EDI, and potential obstacles to implementing this infrastructure. Software standards are discussed as well.

The appendix lists the EDI transaction sets with approved ANSI standards as of October 1990.

## II. RESEARCH APPROACH

In our efforts to answer the study questions posed in Section I,<sup>1</sup> we conducted interviews with DoD logistics policymakers, managers, and workers; with representatives of other federal agencies involved with EDI; with private sector businesses using EDI; and with vendors providing EDI-related services. We then analyzed all available quantitative data on DoD logistics pipeline performance, other relevant logistics information, and the limited data available on the performance of existing DoD EDI efforts, along with pertinent literature, statutes, and regulations. As part of the two case examinations, various sample data sets were collected and analyzed, including survey data from users of one DoD EDI application.

We did not conduct a comprehensive survey of the extent to which DoD components currently use EDI. We did, however, review the results of two such surveys conducted by the Office of Management and Budget (for DoD and other federal departments in 1989) and by the Defense Logistics Agency, or DLA (for DLA usage).<sup>2</sup>

Described below is the approach we used to analyze these sources of information in each logistics function and the EDI cases examined.

Four logistics functions were examined: procurement, supply, transportation, and maintenance and repair.<sup>3</sup> The study focused on secondary-item procurement in contrast to the acquisition of "major systems"<sup>4</sup>—e.g., tanks, aircraft, and ships—because secondary procurement directly affects the readiness and sustainability of available weapon systems during peacetime and war. Secondary procurement includes the purchase of all reparable and consumable parts for weapon systems needed to maintain readiness and sustainability. Because the demand for these critical parts is unpredictable, the logistics functions involved in meeting users' demands (i.e., procurement, supply, and transport) must be dynamically responsive.

<sup>1</sup>See p. 2 of Section I.

<sup>2</sup>The results of these surveys have not been formally published.

<sup>3</sup>Requirements planning and determination and reutilization and the marketing of surplus materials were excluded because these logistics functions do not directly affect the pipeline (the activities between a user's request and its fulfillment).

<sup>4</sup>See Federal Acquisition Regulations (FAR) paragraph 34.001 for a detailed definition of "major systems." The terms *acquisition* and *procurement* are used interchangeably in this report, although acquisition is sometimes used to refer to the full process of requirements planning and determination internal to DoD as well as the solicitation and award process.

The mission of logistics, as stated earlier, is to support the user in the field with what is needed when, where, and in the condition and quantity required at the minimum expenditure of resources. Hence, most logistics activities can be seen as a task along a pipeline between a field user's request and its fulfillment. The shorter, more accurate, and more responsive this pipeline, the better the logistics functions perform.<sup>5</sup>

EDI can make the pipeline between a request and its fulfillment shorter, more accurate, and more flexible. Specifically, it can **shorten the pipeline** by delivering transactions faster, eliminating or shortening steps such as data entry, and enabling simultaneous delivery to many recipients or to self-identified recipients (i.e., to recipients whom the sender does not specifically identify or know, such as readers of an electronic bulletin board of EDI transactions). Similarly, EDI can **make pipeline actions less prone to error** by eliminating the need for rekeying data into computers upon receipt. This could reduce errors in what is bought, repaired, or delivered to where and at what priority.<sup>6</sup> Finally, EDI can **make the pipeline more flexible** by allowing transactions to be exchanged with less effort and hence more frequently and by easing the effort needed to adjust or monitor those transactions. In logistics, this could mean responding more effectively to dynamic changes in demands and monitoring the status of transactions more dynamically in the "external" pipeline (i.e., in non-DoD hands).

EDI's effects may or may not result in significant enhancements to logistics. If, for example, a pipeline segment (i.e., a set of tasks) to which EDI is applicable does not take much time now, rendering it shorter or more flexible may be of little value. Similarly, if methods are already used to ensure the accuracy of a given set of tasks (or to correct important errors), further improvements in accuracy would not be worthy of pursuit. We thus sought to identify those applications in which EDI was likely to enhance logistics and to develop in-

<sup>5</sup>Ideally, the mission of logistics should be translated into a measurable goal such as weapon system readiness and sustainability, not pipeline performance. When such data are available and can be linked to logistics tasks, they should be used. Unfortunately, such links are difficult and often unavailable to defense analysts. In this study, we focus on pipeline performance for high-priority items as a proxy for support of DoD's mission.

<sup>6</sup>An important caveat is needed here. Pipeline actions may be less prone to errors owing to fewer data entry errors, but they may nonetheless be *less accurate*—i.e., not reflecting a user's needs as accurately—because accuracy in some transactions may depend on human judgment and expertise, which is now reflected in manual systems but is much more difficult to reflect in standardized electronic transactions.

sights into the complex intermingled effects of EDI by examining logistics function pipelines to pinpoint those segments that EDI could potentially affect and their potential benefit in view of overall pipeline length. We sought transaction subsets where EDI would be especially beneficial—and we identified new ways of conducting business that would be needed to achieve potential gains. These assessments are reported in Section III. In Section IV, we identify obstacles that inhibit the realization of EDI's potential gains.

Throughout our analysis, we relied on existing DoD data sources. Because these data are not necessarily collected to facilitate the measurement of such effects, we were in many cases unable to precisely measure the benefits and costs of EDI. Nor did we estimate gains simply from eliminating paper transactions, because these can be misleading; merely moving from paper to electronic form misses the much larger potential gains made possible by the integration of EDI within logistics functions.

Because it is difficult to examine specific obstacles and prerequisites to the achievement of potential EDI gains by focusing on broad DoD-wide applications, the current study included an examination of actual EDI use in two DoD cases, one in transportation and another in procurement. These are:

- The use of EDI in transportation by the Marine Corps Logistics Base, (MCLB), Albany, Georgia. This application was part of a DoD-wide pilot project to introduce EDI into transportation to enable electronic invoicing of transportation services.
- The use of EDI by the Medical Directorate in DLA's Defense Personnel Support Center (DPSC) to procure medical supplies for overseas medical facilities. SAMMS Procurement by Electronic Data Exchange (SPEDE),<sup>7</sup> the EDI system used, electronically solicits, receives, and evaluates bids and then makes awards to over 40 prequalified vendors with established blanket purchase agreements.

We refer to these cases throughout the remainder of the report. The case results are, of course, not generalizable to all DoD activities in a particular logistics function. They do, however, offer specific examples of ways to estimate the potential or actual benefits of EDI and its effects on logistics. Similarly, they identify ways benefits of EDI

<sup>7</sup>SAMMS is DLA's Standard Automated Material Management System.

can be extended through changes in EDI's integration into the logistics process.

We also examined the potential use of EDI to enhance the repair of weapon system components by contractors. No defense component is actually doing this. We particularly looked at the potential gains and obstacles to doing so in the contract repair of certain F-16 components by the Air Force Air Logistics Center (ALC) at Hill Air Force Base.

### III. FIVE KEY TARGET AREAS FOR EDI TO ENHANCE LOGISTICS

What logistics problems are likely to be solved by EDI? Our analysis of logistics functions points to five promising ways in which EDI can be used to improve logistics processes directly or indirectly by addressing current weaknesses or problems in logistics pipelines. Specifically, EDI can:

1. Shorten procurement administrative lead time, including presolicitation, solicitation, and award time as well as order placements against approved contracts;
2. Broaden and hasten access to the industrial base, thereby enhancing procurement responsiveness;
3. Allow for tighter and more dynamic control over vendor performance and actions of all sorts—e.g., in the procurement of commodities, in transportation, or in repair or maintenance services;
4. Provide short-term, accurate “heads up” to logistics pipeline actors within and outside DoD; and
5. Enable better responses to unpredictable surges in demands for goods or services.

Table 3.1 shows how the five target uses above may directly and indirectly affect the four logistics functions examined. As can be seen, these target areas appear to offer significant potential enhancements to logistics.

These five targets, however, will significantly enhance logistics only when a relevant problem warrants solution. For example, if procurement administrative lead time (PALT)<sup>1</sup> is already short for a given commodity, the first target use of EDI cannot yield significant benefits. In the paragraphs that follow, we discuss when and how EDI may be most beneficial for each of these targets—citing, where possible, specific examples of logistics pipelines that could be im-

<sup>1</sup>The time between a purchase request (i.e., the decision to make a purchase to replenish stock or directly meet a user's demand) and a purchase award (i.e., a legal commitment to buy from a specific vendor, or an order placement against an approved contract).

Table 3.1

KEY TARGETS FOR EDI AFFECT FOUR LOGISTICS FUNCTIONS<sup>a</sup>

Procurement	Transportation	Supply	Maintenance and Repair	Improvement to Logistics Process
X	I	I	I	Shorten procurement administrative lead time.
X	I		I	Broaden and speed access to the industrial base.
I	X	X	X	Enable tighter, more dynamic control over vendor performance and actions.
	X		X	Provide short-term, accurate "heads up" to pipeline actors within and outside DoD.
X	X		X	Enable better responses to unpredictable demands or surges in demand.

<sup>a</sup>X indicates a direct effect; I indicates an indirect effect.

proved and new techniques that either are made possible by EDI or are required to achieve potential EDI gains.

We have not attempted a parallel organization of the discussion for each of the targets, as the information available and the areas of concern vary from one to another. For target one, we break down the copious information on procurement according to the size of the effect, the locus of gains, and new techniques needed, and we then address the indirect effects together. For target two, the principal dichotomy is between two subtargets. Targets three and four are organized by logistics functions. Target five does not require subdivision. This section concludes with a discussion outlining why none of the targets focuses on EDI's potential ability to reduce clerical or data entry errors.

## TARGET: SHORTEN PROCUREMENT PIPELINES

EDI allows DoD to procure some of what it needs more rapidly by shortening PALT.<sup>2</sup> Essentially, it does so in two ways:

- It *shortens presolicitation* by abbreviating the time needed to announce the intent to solicit. EDI also simplifies the search for competitive vendors by (1) reaching preidentified vendors both faster and simultaneously; (2) allowing vendors to identify themselves; and (3) better tapping non-DoD markets.
- It *shortens solicitation or order placement* by (1) exchanging the required multiple transactions electronically; (2) automatically incorporating these transactions into internal contracting systems for action; (3) soliciting all qualified and interested vendors simultaneously; (4) placing orders electronically against existing contracts; and (5) using electronic access to basic ordering agreement vendors to speed up pricing or other terms of an order.

Ways of potentially reducing PALT are discussed below. Following this discussion, important indirect effects of reducing PALT are discussed.

### How Large Might Gains Be from Using EDI to Reduce PALT?

To estimate the potential ability of EDI to reduce PALT, we must first know the number of presolicitation and solicitation procurement transactions DoD exchanges with vendors and how long these transactions now take to complete. We then need to narrow our estimate to apply only to that subset of transactions for which EDI appears most feasible and beneficial.

In FY88, DoD made \$151 billion in procurement awards involving 15 million procurement actions,<sup>3</sup> requiring even more transactions during presolicitation and solicitation<sup>4</sup>—and 98 percent of these actions were for \$25,000 or less. Furthermore, nine million DoD pro-

<sup>2</sup>See prior footnote for a definition of PALT.

<sup>3</sup>Department of Defense Summary of Procurement Awards, FY88, Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, Washington, D.C. By definition of the Federal Procurement System, procurement actions include initial contracts or modifications to them, orders under contracts, orders against federal supply schedules, and contract termination actions for default or convenience.

<sup>4</sup>For example, requests for bids or quotes are not counted as procurement actions.

curement actions, or 69 percent of all of DoD transactions for work in the United States, were with small businesses.<sup>5</sup> DoD's prime contractors, in turn, awarded \$25 million to small-business subcontractors, representing 38 percent of their subcontract awards.<sup>6</sup> In short, DoD handles well over 15 million procurement transactions annually, most of them transacted with small businesses, for well under \$25,000.

Despite their small size, these transactions generally took a long time to complete. Given this study's focus on wartime readiness and sustainability, our interest lies in speeding up the procurement of weapon system spare parts or other items directly linked to readiness and sustainability. In fact, total procurement lead time (PCLT)<sup>7</sup> for spare parts has been a DoD concern for some time.<sup>8</sup> PCLT for stocked, secondary items (a proxy here for spare parts) is estimated to be 634 days in FY91 (weighted by the value of the procurement), with administrative lead time (ALT) estimated at 211 days.<sup>9</sup> The remaining 423 days of PCLT is production lead time (PLT), which is not directly affected by EDI.

For stocked items with adequate stock levels, reducing ALT will not affect the actual receipt time for end users. Instead, it will affect only the time needed to fill stock and thus the level of stock to be maintained. In FY89, however, 16 percent of demands for stocked items—or some five million demands—could not be met from stock on hand. Hence, reducing ALT will affect responsiveness to users for a significant portion of demands.<sup>10</sup> DoD-wide, users requesting such

<sup>5</sup>This excludes 1.1 million transactions from work outside the United States with foreign or domestic firms and another 1.1 million with foreign governments, U.S. government entities, or education and nonprofit institutions.

<sup>6</sup>DoD, 1988c.

<sup>7</sup>PCLT is a broader portion of the pipeline than PALT, described earlier. PCLT is defined in DoD Instruction 4140.55 (December 9, 1985) as the time from when a wholesale item inventory level reaches its reorder point until it is procured and available for issue. It is made up of four subsegments: reorder point "trigger" to purchase request (sometimes referred to as "pre-PALT"); purchase request to award (PALT); award to ship time by vendor; and shipment from vendor to receipt at wholesale point. These segments are grouped into two larger segments: ALT (administrative lead time) from reorder "trigger" to award (note that PALT is a subset of ALT); and PLT (production lead time) from award to receipt.

<sup>8</sup>See, for example, Office of Federal Procurement Policy, 1984, and DoD, 1989. Not all "secondary items" are used on weapon systems, but the majority are. No more specific data are available on PCLT for spare parts alone.

<sup>9</sup>Office of the Assistant Secretary of Defense (OASD), January 1990, unpublished estimate from ongoing analysis. These estimates only are for secondary items with National Stock Numbers assigned and that are stocked. See prior footnote above for explanation of these pipeline segments.

<sup>10</sup>MILSTEP Highlight Table, Supply Availability and Workload Analysis Report, FY89, DoD Total, Stock and Non-Stock Funded Stocked Items, MILSTEP Central Data

out-of-stock items had to wait an average of 74 days.<sup>11</sup> This 74-day period provides a reasonable measure of how much procurement can directly affect users. Clearly, most of the time, items with long PCLTs are ordered far in advance of their need. Given the uncertainty of demands, however, some requisitions still must wait the entire procurement lead time before they are filled. Figure 3.1 illustrates the pipeline from user demand to receipt when an item is not immediately available upon requisition.

A closer examination of procurement lead times reveals that those for the great majority of small buys are shorter than 74 days but are still quite lengthy. Although no aggregate data are available on PALT for the roughly four million spare parts LoD uses, some 2.2 million of these are known to be purchased by DLA through its four "hardware" centers,<sup>12</sup> and some 1.1 million of these spare parts are essential to weapon systems.<sup>13</sup>

Timelines for DLA's four centers provide a reasonable guide to the potential gains that can be derived from EDI. For these hardware centers, the PALT for large buys was 150 days in FY89, and 58 days for purchases of \$25,000 or less.<sup>14</sup> Given that some 95 percent of the Defense Logistics Agency's (DLA's) procurement actions are for \$25,000 or less,<sup>15</sup> a relevant PALT to focus on for spare parts is 58 days for the majority of spare parts buys and 150 for the larger and more infrequent buys.<sup>16</sup>

Collection Point, the Defense Automatic Addressing System Office (DAASO), December 1989.

<sup>11</sup>MILSTEP Highlight Table, Pipeline Segment Analysis, FY89, Worldwide, DoD-wide, DoD, MILSTEP Central Data Collection Point, DAASO, December 1989.

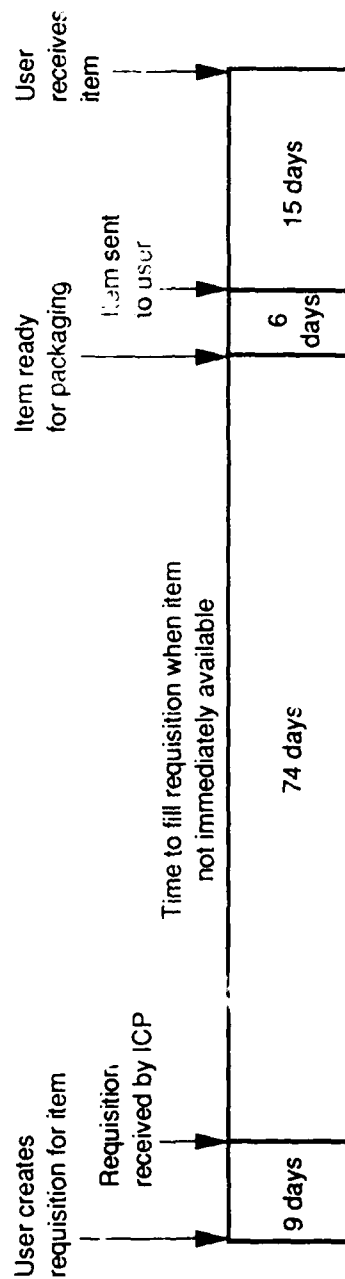
<sup>12</sup>OASD estimate. These hardware centers are DGSC, DCSC, the Defense Industrial Supply Center (DISC), and the Defense Electronics Supply Center (DESC). This excludes DLA's other two supply centers, DFSC and DPSC, which purchase fuel, subsistence, and medical supplies. Spare parts data from (Office of Federal Procurement Policy, 1984).

<sup>13</sup>Briefing to Aviation Supply Office, JCP Academy, by Captain Elliot, SC, USN, DLA Readiness Support Office, January 1989. Many more may be essential but are not yet coded so by the services.

<sup>14</sup>DLA Administrative Support Center, final PALT data for FY89, November 7, 1989.

<sup>15</sup>DoD, 1988a, Table 16.

<sup>16</sup>This probably underestimates PALT for spare parts because, in general, DLA procures commodities common across services or weapon systems and those past the development stage. For this reason, DLA-managed parts are likely to be somewhat easier to find and somewhat more likely to be available commercially—and thus are more likely candidates for the application of EDI. Hence, PALT is long even for small buys.



NOTE: Total pipeline time is distributed over MILSTEP segments, FY89, averages, weighted by volume across transportation priority groups, CONUS versus overseas. The transit time and receipt take-up time calculation (15 days) is derived from averages, overseas air shipments across MILSTEP areas.

Fig. 3.1—Logistics pipeline for items not immediately available worldwide, DoD total, FY89

In summary, then, it would appear that a lower bound on a PALT estimate for spare parts is 58 days—a formidable pipeline segment. It is also known that many user demands are directly affected by PALT when necessary items are out of stock. Given that failure rates of weapon systems are difficult and in some cases impossible to predict and that the lack of spare parts significantly delays repairs to such systems, even a 10 to 20 percent reduction in PALT could have a measurable effect on readiness and sustainability. As more responsive repair approaches are introduced by the services, reductions in PALT for consumable items used in repair will become even more crucial. For example, when the Air Force implemented a prototype for responsive repair prioritization, lack of consumable repair parts on hand held up over 40 percent of repairs.<sup>17</sup>

There are few documented instances in which EDI has dramatically decreased PALT in DoD applications. DLA's hardware centers combine the use of EDI with the establishment of indefinite delivery contracts (IDCs)<sup>18</sup> with vendors. When the Defense General Supply Center (DGSC) implemented an electronic order placement system (Paperless Ordering Placement System, or POPS) against IDCs, PALT dropped from approximately 18 days to 13 days, representing a 28 percent reduction.<sup>19</sup>

Generally, sending EDI transactions electronically can reduce transit time by three to five days in each direction. Given the number of documents required in any one solicitation, this can translate into a decrease of ten or more days in procurement time.<sup>20</sup>

SPEDE demonstrates gains from EDI beyond reductions in transit time alone. DPSC, for example, uses SPEDE to solicit quotes from a rotating list of vendors, to evaluate these quotes automatically, and, given carefully set parameters, to make an award automatically.

<sup>17</sup>Ongoing RAND research for the Air Force.

<sup>18</sup>Indefinite-delivery contracts defined in FAR 16.5.

<sup>19</sup>This is a comparison of PALT assumptions prior to implementation of DGSC's POPS estimates of actual PALT using the system. It assumes that the prior assumptions reflected PALT prior to the use of POPS. See Office of the Inspector General, 1987, pp. 5-6.

<sup>20</sup>It is important to emphasize that EDI alone is not the only means of reducing PALT. For example, DLA hardware centers have demonstrated dramatically how the use of internal, automated contracting systems coupled with available contracting arrangements can reduce PALT, most not yet incorporating EDI approaches. PALT for small manual buys (\$10,000 to 25,000) was 91 days in FY89. Where small purchase competition was required, PALT rose to 107 days. If solicitation packages were electronically produced directly from an automated contracting system and then mailed and evaluated manually, PALT dropped to 69 days. If contracts were set up in advance and orders simply made against them, PALT dropped to three days. Some of these orders are sent electronically, but most are delivered by phone calls or mail.

With these links between internal systems and vendors, SPEDE reduced PALT from 14 to 8 days, or by 43 percent—even though the same items were already being procured prior to SPEDE via a less sophisticated electronic system. PALT for buys of roughly comparable commodities at DPSC was 32 days: four times higher than SPEDE. And SPEDE's significant savings do not yet reflect opportunities offered by EDI to tailor response times by priorities and to solicit many vendors simultaneously, thereby circumventing the need to await "no bid" responses or to resolicit vendors when insufficient quotations are received.<sup>21</sup>

In summary, EDI can dramatically reduce PALT for millions of transactions annually, both large and small. The procurement of weapon system spare parts appears to be an especially good target on which to apply EDI. We will now narrow this target further.

#### **Where Is EDI Most Likely to Yield Reductions in PALT?**

EDI cannot be applied to all types of procurements—and even where it can be applied, it will not always reduce PALT or improve readiness and sustainability (see Table 3.2). Instead, the commodity or service chosen must be critical to readiness and sustainability—e.g., weapon system critical—and the length of PALT must pose a significant problem. Also, if EDI is to be of use, the service or commodity procured must be capable of being electronically described to fit within an EDI transaction. And if EDI is to be used in the competitive process, quotations and the criteria by which they are evaluated must be objectively and electronically definable. Hence, complex proposal responses are not likely candidates for EDI, but orders against them are amenable to EDI. Similarly, cost worksheets submitted in electronic format can dramatically speed cost analyses.

Table 3.1 also lists factors that are likely to facilitate the implementation of EDI to reduce PALT. If the commodity is in an industry advanced in the use of EDI, for example, EDI is likely to be more eas-

<sup>21</sup>Currently, the SPEDE parameters defining delinquent quotations are the same across priorities (five days), and only three vendors are solicited at once. These vendors are chosen on a rotating basis from vendor lists by Federal Supply Class, although SPEDE places a call to each vendor nightly during which it could easily deliver RFQs to any interested vendor. If two of the three vendors do not respond, a SPEDE RFQ is usually resolicited, lengthening PALT. Most of these resolicitations could be eliminated through the initial solicitation of all qualified vendors. Seventy-five percent of SPEDE vendor respondents wanted this change from the current three-vendor-per-RFQ procedure.

Table 3.2  
NARROWING THE TARGETS FOR REDUCING PALT WITH EDI

Characteristic of Likely Target	Possible Measure
Where Reducing PALT Will Enhance Logistics	
PALT constrains logistics effectiveness	Demand is unpredictable or subject to surge PALT constitutes a significant share of total pipeline
Item is critical to weapon system or readiness and sustainability	Defined by service; DLA alone manages 1.1 million weapon system spare parts
Required vendors are difficult to find	Five percent of awards are to small, disadvantaged firms set aside for labor surplus areas
Prerequisites for Using EDI to Reduce PALT	
Item is unambiguously definable	Forty percent of DoD active NSNs are "fully described"
If EDI is used in solicitation, criteria must be clear and objective	Likely to exclude more awards over \$25,000 than under owing to FAR rules
Makes Using EDI Easier or More Beneficial	
Commodity is from EDI-advanced industry	Examples include the aviation, automotive, and medical industries; number is growing
Volume of procurement transactions in category chosen is high	DoD courts are available by buying location: 14.7 million transactions annually
DoD contracting system can produce electronic transactions to vendors	All defense components have such systems now or under development
Item is commercially available	No direct measure exists; number is growing owing to "breakout" efforts
Few sources exist; sources are difficult to find	On wholesale buying locations' "hit lists"

ily implemented and gains are likely to be greater because vendors will probably be more capable of incorporating EDI transactions into their internal systems. As an illustration, when SPEDE was implemented within the medical supply industry—an industry that is relatively advanced in the use of EDI—it came as no surprise that 52 percent of SPEDE vendors reported that they already exchanged EDI transactions with other suppliers or customers or planned to do so

within a year. These percentages are far higher than those of a general survey of large business use of EDI.<sup>22</sup>

Table 3.1 also shows that if there are many transactions to be made in the chosen category, overall EDI-derived gains may be greatest. If the relevant internal DoD contracting system can produce electronic transactions and, more important, accept such transactions, EDI's benefits will be much more likely to be realized.<sup>23</sup>

In a similar manner, if an item or service (e.g., a repair) is commercially available and describable, EDI gains may increase, because EDI can enable the buying point to participate in an electronic commercial marketplace via available interorganizational databases.

Finally, EDI gains in the competitive process are most likely to occur where few sources can be found. Although the percentage of DoD buys awarded competitively is impressive, each buying point has a list of items for which it cannot find enough sources. These items will be further discussed under the next target.

### **New Techniques Needed to Achieve PALT Reductions**

Some of the potential reductions in PALT with EDI can be achieved simply through the establishment of electronic links between current vendors and DoD's internal contracting systems. Many other potential uses of EDI to reduce PALT, however, will require new techniques—i.e., new ways of handling presolicitation and solicitation.<sup>24</sup> Several of these techniques are described below.

**Noncompetitive Procurement or Order Placement.** Electronic order placements against preexisting contracts can be used more extensively to exploit the speed with which transactions can move with EDI. This application of EDI will be facilitated by the extended use of two available contracting vehicles: indefinite-delivery contracts (IDCs) and blanket purchase agreements. Although many DoD buying points use IDCs that they have set up or that the national inventory control point (NICP) has established for local use, IDCs are still underutilized as a means of reducing PALT and of exploiting order placement via EDI.

<sup>22</sup>Masson and Hill, 1989.

<sup>23</sup>For descriptions of the status of various DoD automated contracting systems, see Drake, 1989.

<sup>24</sup>Some of these require changes in rules, e.g., the FAR. Many do not. Any requisite changes to the "rules" will be discussed in more detail in Section IV.

In efforts to reduce administrative overhead and attract vendors, DoD typically sets up contracts such as those described above as multiyear requirements contracts combining several items so that vendors will have more business at stake and hence a stronger incentive to meet demands rapidly. (Many private sector firms use this technique—i.e., combining sources for many items to implement just-in-time inventory management.) Such contracts can move formerly small buys (i.e., those not exceeding \$25,000) into the large-buy arena and out of the current small-business set-aside program. In the POPS system mentioned above, small businesses have not been eliminated as IDC vendors (in fact, in early 1990, 16 of the 31 POPS vendors were small businesses), but uncertainty regarding *when* such buys could be justifiably moved to the large-buy arena may inhibit the extension of this useful technique to the reduction of PALT. Interestingly, private firms report that small businesses are often better suppliers in such arrangements, because a larger share of their business is directed to the support of one large firm.

Purchase orders can also be placed electronically with sole-source contractors, as the Air Force is prototyping with its Manufacturers and Government Interconnected by Computer (MAGIC) system at Ogden ALC. Such simple electronic order placements may be used with many buys under \$10,000 where competition is not required.

NSC Jacksonville is experimenting with the use of innovative "super RFQs" on its electronic solicitation bulletin board. With their system, individual purchase requests are grouped "on the fly" over a short number of days to match the manner in which vendors combine products. To attract more vendors and eliminate the need to handle many more small buys, these grouped purchases are then posted as combined RFQs, all under \$25,000.

Another new technique using EDI (or, at this time, an EDI-like technique) is aimed at shortening the time needed to obtain an acceptable price on a buy from a basic ordering agreement (BOA) vendor. The Navy Aviation Supply Office (ASO), for example, has a pilot system with which vendors' predetermined price files can be electronically queried—rendering the pricing process, which once took over 100 days of PALT, virtually instantaneous for the items included. As with IDCs, however, vendors must be reasonably certain that the items in question will actually be ordered before such pricing files are set up. A cross-vendor database including price and availability data might reduce PALT even further.

**Competitive Procurement.** Additional techniques can be used to reduce PALT for competitive procurements. The FAR requires that

intended buys be well publicized to increase competition, broader industrial participation, and help small disadvantaged businesses and those in labor surplus areas.<sup>25</sup> To meet this objective, the FAR currently requires that all solicitations exceeding \$25,000 (and sometimes those exceeding \$10,000) be listed in the hard-copy CBD for 15 days, with an additional mandatory solicitation period of 30 days before award.<sup>26</sup> Hence, the minimum length of PALT for such actions is predetermined by FAR requirements. PALT is further extended for larger awards, since agencies are required to allow an additional 10 days between the time a presolicitation announcement is submitted to the CBD and its actual publication there. (Only six days is required if the announcement is submitted electronically to the CBD.)

DoD succeeds in procuring the majority of its items competitively.<sup>27</sup> Yet the use of EDI with electronic bulletin boards or broadcasting systems could help DoD find relevant firms more quickly and complete buys faster.

The CBD could even be replaced as the mandatory vehicle for reaching interested vendors. Instead, presolicitation announcements and solicitations in EDI formats could be posted on one or more electronic bulletin boards, thereby improving DoD's ability to meet the FAR's competition objective while shortening the time needed to do so. These electronic tools could include not only CBD-required solicitations of over \$25,000, but also the vast majority of DoD buys for lesser amounts—buys that are now accessible only from buying locations in various forms or through private bidders' services.<sup>28</sup> The bulletin boards' electronic format could not only speed vendor access but *improve* access as well; both small and large vendors would be able to reach the boards from their places of business. Thus, the FAR's intent could be met more effectively—and its deadline re-

<sup>25</sup>FAR, Part 5.002.

<sup>26</sup>FAR, Part 5.201(c).

<sup>27</sup>In FY88, 59 percent of all DoD procurement actions were competed, representing 51 percent of the total value of the actions. Competition rates were roughly the same for actions above and below \$25,000. Fifty-nine percent of actions equal to or under \$25,000 were competed, constituting 51 percent of the dollar value. Sixty-five percent of actions over \$25,000 were competed, constituting 51 percent of their value. Department of Defense Summary of Procurement Awards, FY88, Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, Washington, D.C.

<sup>28</sup>Several private firms currently offer the CBD in electronic form for a fee, with various levels of search capabilities and sometimes coupled with other bidders' services. The federal government does not provide it online to prospective vendors. The hard-copy version is considered the official version for which time standards are set.

quirements, set to ensure that vendors have adequate time to review the CBD, could be radically reduced, in turn reducing PALT.

Where possible, such EDI bulletin boards and databases could be shared across DoD buying points and even with non-DoD buyers to attract more vendors, thus reducing the time and substantial resources DoD needs to find vendors. This approach could in turn allow more DoD procurements to be made locally—i.e., closer to the end user—without sacrificing access to a wider marketplace where such access would be advantageous. For example, a bulletin board linked internally to DoD vendor performance and procurement history files could be centrally maintained by an inventory control point (ICP) or even by several ICPs in combination. Where appropriate, local buyers could then post either “spot” buys of urgently needed NSNs or non-NSNs (parts lacking on assigned NSN). The higher the demand for specific items combined in a single bulletin board, the more attractive that board will be to vendors. ICPs could also use the bulletin board to monitor purchasing patterns and to identify opportunities for combining buys or setting up more advantageous purchasing arrangements to save money and time.

There are three ways in which electronic bulletin boards (“electronic CBDs”) could further reduce presolicitation and solicitation times: they could be searched by vendors or by third parties on vendors’ behalf; they could be linked with other DoD electronic contracting systems to *receive* responses (e.g., quotations) from vendors; or they could allow vendors to post information and to identify themselves as interested and qualified sources.

An electronic bulletin board is a one-way tool allowing users access to posted information. The second way this tool could be developed to reduce PALT would be to combine it with links back to DoD. Vendors could respond electronically to announcements or solicitations on the boards, thereby initiating a series of procurement transactions. (Critical controls needed for such exchanges are discussed in Section V.) This link is now missing in the versions of electronic CBD services offered by private third parties; users must currently respond via conventional channels.

DoD is already using electronic bulletin boards for procurement on a limited basis. The General Services Administration’s (GSA’s) electronic Multi-Use File for Inter-Agency News (MUFFIN) system, for example, provides DoD buyers with information on vendors on GSA federal supply schedules for some 110,000 items.

### Indirect Effects of the Use of EDI to Reduce PALT

EDI's improvements to PALT can have several important indirect effects on logistics functions other than procurement. They can, for example, reduce stock levels, decrease excess stockage resulting from inaccurate projections of demand, and improve the quality of procurement. Hence, the reduction of PALT may enhance the effectiveness *and* the efficiency of logistics. These and other indirect effects are discussed below.

As PALT drops, goods can be received at times that more closely approximate when they are actually needed, and inventory levels do not have to compensate for excessive lead times. Further, excess stockage can be reduced because demand for items will not have to be projected so far into the future. (This is one of the major applications for EDI in the private manufacturing sector, where EDI is used as a prerequisite for just-in-time inventory techniques.) The use of POPS by DGSC resulted in possible inventory savings of \$11.2 million, allowing safety inventory levels to be maintained. Destination transportation costs were also reduced by \$732,000 in FY85, a period in which vendors were made to deliver electronically generated orders directly to user locations.<sup>29</sup> By FY89, DGSC was able to pass these savings along to end users by reducing its surcharge on its POPS-managed items from 17.5 percent on regularly handled items to 3.9 percent of purchase price—representing a 78 percent reduction in such charges. Of course, these reductions in PALT cannot be attributed to EDI alone but rather must be seen as a product of its use in combination with indefinite delivery contracts.

EDI can also improve the quality of procurements. A 1989 senior DoD conference on reducing lead time on secondary items concluded that the most significant impediment to value-based contracting lay in the lack of accurate, timely, and accessible databases on vendor performance. If procurement transactions to and from vendors are electronic, data on such transactions can be rapidly combined with other vendor-related data in electronic databases. These databases are critical to various efforts to develop vendor performance profiles for use in incorporating the full cost of procurement from a particular vendor into procurement decisions. Central buying points could make vendor performance, procurement history, detailed item descriptions,

<sup>29</sup>Office of the Inspector General, 1987, p. 9. At the time of the audit, not all of these savings had been realized owing to a lack of changes in PALT assumptions regarding required inventory level calculations.

and even preestablished contractual vehicles available for use by local buying points.

Just as the use of EDI transactions would facilitate the collection and use of aggregate procurement data for DoD, so would it facilitate the provision of some of these data to vendors themselves. SPEDE vendors, for example, especially valued the receipt of winning bid information.

Finally, reducing PALT indirectly affects transportation and maintenance/repair because these two functions depend at least in part on the procurement of services from contractors. Military Traffic Management Command (MTMC), which coordinates transportation services procured by DoD, could use EDI links to vendors to verify proposed charges (or even to allow charges to change more fluidly depending on the responsiveness needed from carriers) as well as to ascertain the availability of special equipment and lift and to determine a vendor's willingness to accept a load. MTMC could even send tender information to several carriers, thereby streamlining the MTMC approval process—which, in our case analysis of transportation at MCLB, Albany, significantly lengthened the time needed to arrange transportation. Transportation for the median high-transportation-priority item *not* requiring an MTMC release took two days to arrange, compared with eight days with an MTMC release.<sup>30</sup>

#### **TARGET: BROADEN AND SPEED ACCESS TO THE INDUSTRIAL BASE**

This section describes two ways in which EDI may help broaden and hasten access to the industrial base relevant to DoD and maintain access to the firms with which it now does business. First, however, the nature of DoD's concerns regarding the industrial base must be discussed.

##### **DoD's Interest in the Industrial Base**

The industrial base of interest to DoD consists of those firms that make products which DoD needs (the so-called first tier of the industrial base) and of firms that make ingredients to these products (the

<sup>30</sup>Median MILSTEP Transportation Hold segment lengths are based on a transaction sample taken in summer 1989. MTMC has a new information management system in development, consolidated freight management (CFM), which will affect how MTMC plans transportation routes.

second and lower tiers, consisting of suppliers to DoD's suppliers). No one knows how many firms conduct business with DoD each year or how many firms produce products DoD uses but are not interested in doing business directly with DoD. We do know that over 300,000 firms are *interested* in doing business with DoD<sup>31</sup> (roughly 40 to 50 thousand "parent" companies received procurement awards over \$25,000 in FY89,<sup>32</sup> but most awards are under this amount). Data on the lower tiers of the industrial base are even more difficult to find.

The size of DoD's industrial base has been a national concern for at least a decade. The general perception is that the absolute size of this base has been shrinking, either as a whole or in particular sectors. Existing data, however, are insufficient to the task of documenting the extent of these problems,<sup>33</sup> although there is agreement on two problems bearing on the potential use of EDI:

- Too many of DoD's buys are from single sources, limited sources, or foreign suppliers.<sup>34</sup>
- Not a small number of firms decline to do business with DoD because of the difficulties involved—e.g., regulations, reporting requirements, and slow payments.<sup>35</sup>

With respect to the first problem, the Defense Industrial Network (DINET), a DoD electronic system that tracks sources of supplies by weapon system, has substantiated vulnerabilities at the first tier of the industrial base. Indeed, such problems extend beyond this first tier of direct suppliers to DoD down through the tiers of firms supporting these contractors. One recent study cites examples in which the lack of a known supplier on the sixth tier down from the prime

<sup>31</sup>In FY89, 335,000 firms had Contractor and Government Entity (CAGE) codes, meaning that they have done or have confirmed their interest in doing business with DoD within the last three years; entries in the CAGE file are confirmed on a rotating, three-year basis.

<sup>32</sup>Federal Procurement Data Center Special Report 87-552, July 17, 1987 for the Office of Federal Procurement Policy.

<sup>33</sup>The validity of the dramatic declines in the number of firms doing business with DoD, documented in Blackwell, 1989, has been disputed in detail by the SBA and DoD. Pilling, 1989, p. 20, reports that the number of defense firms in the second tier "appears" to have declined in the last 20 years but that the actual figures are "debatable." Any decline in the absolute number of firms in the industrial base at any tier is not necessarily a decline in industrial capability because it can be at least partially a result of vertical integration of prime contractors or subcontractors.

<sup>34</sup>Ninety-sixth Congress, 1980.

<sup>35</sup>This problem extends to the second tier of suppliers as well. See, for example, Under Secretary of Defense (Acquisition), 1988, p. 36.

contractor threatened the readiness of a weapon system.<sup>36</sup> Hence, industrial base problems that DoD must address extend far beyond the primary suppliers of major items.

Although no systematic, empirical data are available to substantiate the second problem delineated above, ample anecdotal evidence can be heard at any gathering of DoD vendors. As described in a recent DoD report on the industrial base, this problem extends to prime contractors that deal with suppliers following DoD procurement rules:

Many desirable, highly qualified suppliers refuse to do business with defense prime contractors because of the sheer weight of compliance with the body of laws, regulations, rules, and procedures that primes are required to pass through from the Government to them.<sup>37</sup>

Indeed, each central buying point has a list of items with no vendor, only a single vendor, or too few vendors. For example, despite DLA's impressive competition statistics (95 percent of awards in FY88), and despite the fact that the items DLA manages are more likely than those managed by the services to have commercial equivalents and established sources, each of DLA's supply centers has long "hit lists" of such items. DPSC lists 105 medical items in a recent hit list, for which it spent some \$36 million last year. Other DLA centers were seeking some 300 items valued at \$87 million.

EDI's contribution to improving and speeding access to the industrial base will increase as the following three trends continue:

- A growing number of items DoD buys will have commercial equivalents as a result of multiple efforts to define them or to change specifications so that they are acceptable.
- Given the efforts of the CALS program<sup>38</sup> and related programs, the engineering specifications of many spare parts with military specifications are becoming available in standard electronic form.
- Increasingly, industry-wide electronic marketplaces are emerging in industries such as aviation and other vehicular spare parts, food and clothing, health care, and electronic components.

<sup>36</sup>Grossman, 1989.

<sup>37</sup>Under Secretary of Defense (Acquisition), 1988, p. 36.

<sup>38</sup>See the brief description of this program in Section I, footnote 6.

### How EDI Can Help

EDI can help solve the two problems delineated above by providing broader and faster access to more U.S. firms for DoD procurement both in peacetime and in wartime. The EDI techniques in this target area overlap with those that can be used to reduce PALT. Specifically, EDI can contribute in two ways:

- By helping DoD reach more of the existing industrial base to identify new sources of supply where they are most needed and allowing such sources to identify themselves; and
- By reducing the effort needed by vendors to do business with DoD, thereby increasing the pool of firms willing to do business with DoD.

Certain prerequisites must be met, however, if EDI is to be used to the ends outlined above. If EDI is to be used to access the industrial base more effectively via electronic tools (described below), for example, its benefits are likely to be greatest for items with the following characteristics:

- Items should be capable of being described electronically in sufficient detail to allow them to be uniquely identified.
- The demand for the items must be dispersed, and items must be hard to find at many locations—that is, their availability must be dispersed so that buyers need to use a cross-vendor tool (e.g., a cross-vendor supply availability database or a bulletin board) rather than a small, known set of suppliers.
- Transportation costs from participating suppliers must constitute a relatively small share of the item cost or the cost of not finding an item. If this is not the case, the electronic tools must be structured regionally to keep transport costs acceptable.

We will now address what these two benefits mean and outline how they can best be achieved.

**Afford Better Access to the Industrial Base.** If it is to broaden and improve access to the industrial base, retrieve hard-to-find items, and even maintain the access it now has, DoD must use EDI with electronic tools such as bulletin boards and cross-vendor databases. These tools will permit DoD to tap existing marketplaces more effectively, will allow vendors easier access to opportunities for doing

business with DoD, and will afford vendors the opportunity to *identify themselves* as potential sources of supply. EDI cannot directly increase the number of firms in the industrial base, but it can increase DoD's access to firms that are not yet known to DoD and help firms identify new products to produce. These gains will increase to the extent that such tools can be tailored to the identification of specific sources of hard-to-find items and then provide potential sources with the detailed item descriptions they need to determine whether (1) they already produce something DoD seeks, or (2) it is worthwhile to begin production of a particular item.

The electronic tools to solve industrial base problems will probably need to be more sophisticated than those that are used to reduce PALT. For example, an electronic bulletin board might reduce PALT simply by being accessible to known vendors with blanket purchase agreements or by shortening the communication links between DoD and an accessible pool of vendors. Items on such a board might simply be identified by part number or NSN.

In contrast, a bulletin board whose intended use is to increase the pool of vendors for hard-to-find or sole-source items or services will need to (1) be easily accessible to unknown vendors (e.g., by being part of a public, third-party electronic network or a marketplace bulletin board used by potential vendors); (2) identify items in detail or provide convenient (and, one would hope, electronic) access to detailed descriptions; and (3) perhaps provide some procurement history so that a vendor can assess potential long-term demand. In addition, the bulletin board would probably need to be supplemented by access to a human contact who could provide additional information that is unavailable in electronic form.

Another electronic tool, cross-vendor databases, can be and is used by DoD to locate suppliers of hard-to-find items. The ILS aviation parts database described in Section I is an example of such a tool.<sup>39</sup> Some evidence of the gains such databases offer can be found in the dozens of DoD buying points that use the ILS services. Unfortunately, no systematic evaluation of these gains has yet been made, but DoD users of this service have cited occasions in which access to it has dramatically shortened PALT by identifying hard-to-find materials that were holding up the repair or overhaul of weapon systems.

<sup>39</sup>The ILS database also includes FAA-certified sources of aviation component repair, but this service is not used by DoD and may be irrelevant as it now exists given DoD's repair requirements.

DoD may actually need to create (or participate in the creation of) such tools for DoD and non-DoD users in industries for which access is most critical. Such tools and the networks that connect them to participants could be likened to parts of a nationwide "electronic highway" consisting of the networks, electronic gateways, and electronic market tools for commerce between firms as well as the conventions for doing business through them (e.g., standards and agreements).<sup>40</sup> Just as the physical highway system was created in the mid-20th century as a network for commerce as well as an essential infrastructure for the nation's defense, so would this electronic highway be seen as a vehicle for U.S. commerce as well as a critical element in the effort to maintain and enhance DoD's fast and broad access to industry in peacetime or in war. The greater the number of vendors that used such an electronic highway system for their regular way of doing business, the more advantageous it would be to DoD to tap the resulting industrial base. Conversely, the more vendors used the highway for conducting business, the easier it would be for them to begin to conduct business with DoD on that highway.

If DoD participates in the shaping of this highway (e.g., its networks, conventions, standards, and cross-vendor tools), the more likely it will suit DoD's needs. For example, it is to DoD's advantage that transactions flow easily across industry boundaries and that electronic tools in different industries follow the same standards. Without DoD as such a large cross-industry participant, this may not occur, since different industries may develop different conventions for using the same EDI standards.

Ironically, if DoD does not use EDI opportunistically and help shape the tools enabled by it, EDI could ultimately diminish DoD's access to the industrial base. As specific industries (e.g., health care, transportation, retail groceries, and aviation) rely increasingly on electronic marketplace tools, potential DoD suppliers may exploit other markets.

The structure of emerging non-DoD tools and DoD's own procurement rules currently mandate that DoD build DoD-only electronic tools such as SPEDE, but this need not be the case. Instead, there are ways DoD can influence the development of non-DoD tools to make them usable for DoD—and there are ways in which DoD tools might be made attractive to non-DoD users (buyers) as well. For example, a private cross-vendor stock-availability database would be much more useful to DoD if it simply included a code indicating

<sup>40</sup>See Cohen, 1989, for a discussion of how the electronic marketplace might work.

whether a vendor was *willing* and able to conduct business with DoD in certain categories (e.g., by indicating whether it was an SBA-defined small business in compliance with the Walsh-Healey Act). Conversely, if a DoD bulletin board is well used by suppliers, easy for non-DoD buyers to augment, and flexible enough to allow non-DoD buyers to make noncompetitive buys, these buyers might have a strong incentive to "piggyback" on the DoD bulletin board in efforts to find suppliers. This, in turn, might afford DoD access to a richer and more diverse electronic market.

**Reduce Effort Needed by Vendors to Do Business with DoD.**

DoD's vendors, both large and small, must submit bids, contractual agreements, invoices, and numerous other reports to DoD in prescribed formats, some of which may vary according to the DoD buying point. Sometimes these documents are lost, misdirected, or not completed correctly and must therefore be resubmitted. Furthermore, vendors may have to wait months before receiving payment after goods are shipped. EDI can be used to ease the effort to meet DoD reporting and transactional requirements, speed payments, and even reduce transaction costs in various ways. First, to the extent that DoD uses standard EDI formats, vendors will be able to use the same electronic formats to exchange transactions with DoD as they do with other customers or suppliers. Doing business with DoD via EDI will also be eased to the extent that vendors' internal systems can automatically receive and respond to EDI transactions. For example, a major medical supplier recently reported that the transaction cost associated with customer service orders was \$0.48 per purchase order with EDI as opposed to \$3.48 without it.<sup>41</sup> Similarly, an electronics firm reduced its purchase order cost from \$50 per purchase to \$5 through use of EDI.<sup>42</sup>

SPEDE vendors further attest to these straightforward benefits of EDI, citing their ability to electronically receive RFQs, submit quotes, receive awards, and submit ship notices to DPSC, a DLA supply center. Half the SPEDE vendor survey respondents reported that doing business with DPSC was better than it was prior to the institution of SPEDE, and 73 percent reported that SPEDE was better and more reliable than a traditional phone-based bidding arrangement. Many commented on how much faster it was to do business with SPEDE. Seventy-five percent of the vendor respondents were interested in

<sup>41</sup>Speech by Joseph A. Horvath, Picker International, Inc., EDIA Annual Conference, Washington, D.C., December 13, 1989.

<sup>42</sup>Cafiero and Dearing, 1989, p. 13.

being able to bid on all RFQs in SPEDE, something that is difficult and time-consuming in a traditional manual or phone-based system but involves almost no additional costs under an electronic bidding system.<sup>43</sup>

Seventy-three percent of SPEDE vendors reported that they were interested in submitting invoices electronically, a future SPEDE capability. Vendors can also be paid via EDI through use of electronic fund transfer (EFT) techniques. Several DoD paying points are already implementing electronic payments, and DoD's major EDI effort in transportation is focused on shortening and facilitating the invoice and payment cycle.

Some firms in the auto industry are actually using EDI to create a payment process in which invoices are not required. In Evaluated Receipts Settlement (ERS), a firm issues an electronic order, and a supplier responds by shipping the goods and sending an electronic ship notice. Payment can be triggered either by electronically matching these two documents or by matching them automatically to a third document, a receipt from the receiving point. This technique can significantly reduce the traditional accounts payable function for buyers, thereby reducing paperwork (or electronic transactions) and hence speeding payments.

If EDI can significantly speed payment to DoD vendors by making use of ERS techniques or simply by speeding up document flows, it is also likely to make the idea of doing business with DoD far more attractive to vendors.

Although no systematic data are available yet, NSC Jacksonville reports the same type of vendor response to its EASE RFQ bulletin board. According to NSC Jacksonville representatives, almost all vendors introduced to the system have joined it enthusiastically. Indeed, EASE receives inquiries from vendors from across the country despite the fact that the system currently covers only local procurements from NSC Jacksonville.

Two other ways EDI might be used to ease DoD vendors' efforts are more difficult to implement in that they would require changes in the manner in which business is conducted. First, copies of documents submitted by vendors in EDI formats could be stored by vendors in an "electronic file drawer" for referral by DoD users in the event that DoD's copies are lost or must be sent to more than one DoD point.

<sup>43</sup>As mentioned above, SPEDE is now designed to mirror the traditional small-buy process of sending RFQs to a rotating group of three vendors at a time, although SPEDE places a call to each vendor nightly, during which it could deliver RFQs to any interested vendor.

For example, a small business might store copies of its blanket purchase agreement with a DoD buying point and store its invoices in a DoD-accessible file. A DoD contracting officer could then automatically retrieve such documents, thereby eliminating numerous time-consuming requests for resubmissions. Larger DoD vendors might benefit even more from an arrangement to store complex cost reporting and work status documents.

Second, electronic bulletin boards with EDI transactions could facilitate business with DoD by making use of common boards—or a well-coordinated series of boards—across DoD buying points. Such boards could even be combined with non-DoD solicitations. Boards could also combine some of the dispersed buys from DoD's roughly 1,000 buying points, only 22 of which are DoD-wide NICPs for stocked items. Roughly \$5 to \$7 billion DoD buys in FY89 were made locally—i.e., not at an NICP.<sup>44</sup> Moreover, SPEDE vendors attested to the appeal of combining solicitations; 76 percent reported that they would be more interested in SPEDE if they could bid on RFQs from other DoD or non-DoD buying points. Such electronic tools offer an electronic and potentially much more accessible and searchable version of the various "hit lists," bulletin boards, and business "fairs" each DoD agency now employs.

Finally, the use of EDI to upgrade access to the industrial base should improve DoD's efforts to allow all interested and qualified vendors to compete for DoD business. In fact, the role and activities of the defense components' (and the Small Business Administration's [SBA's]) competition offices could fundamentally change through use of the marketplace tools EDI makes available. Current automated tools such as automated bidders' lists and SBA's Procurement Automated Source System (PASS)<sup>45</sup> could be adapted and linked to each other as well as with new tools to help form the critical pieces of an electronic highway with which DoD could broaden, speed, and, indeed, maintain access to the nation's industrial base.

<sup>44</sup>Working estimate only, OASD, January 1990. Excludes all buys by central purchasing offices or for R&D, fuel, construction, brand name subsistence, services (not commodities).

<sup>45</sup>An electronic system that helps prime contractors find small business suppliers.

### **TARGET: CONTROL VENDOR ACTIONS MORE TIGHTLY AND DYNAMICALLY**

Unlike the first two targets, which primarily affect procurement, the third target outlined above offers potential gains in repair/maintenance, transportation, and supply as well as in procurement. In these four functions, EDI can enhance readiness and sustainability by controlling vendor actions more dynamically and tightly. This capability is especially useful given the uncertainty of demands during wartime and the inherent uncertainty in the demand for weapon system repair even in peacetime. In the paragraphs that follow, we will discuss how EDI can be used in each of these functions to enhance the logistics process and will also delineate potential gains that may be achieved and new techniques that may be required. Some DoD users are already using EDI in supply and transportation, but EDI has yet to find application in contractor repair and maintenance.

#### **Repair and Maintenance**

In FY88, DoD spent \$643 million on contractors' repair of weapon systems—a figure that represents only 25 percent of the total funds expended on weapon system repair across DoD but that signals a significant dependence on private contractors for the repair of weapon systems and their components. For some weapon systems, dependence on contractor repair is even greater. A 1985 study, for example, reported that over half of the Navy's depot-level repairs during wartime will be on aviation and engine components, nearly half of which will be done by contractor or other service facilities.<sup>46</sup> This dependence on contractor repair of weapon systems is not temporary; rather, it is federal policy to rely on the private sector to supply such services unless there is a compelling reason to maintain in-house capabilities.<sup>47</sup>

Currently, the Air Force, the Army, and the Navy all have initiatives under way to enhance the dynamic responsiveness of their own weapon system repair capabilities. At Ogden ALC, for example, the Air Force uses a prototype repair management system called Distribution and Repair in Variable Environments (DRIVE) to prioritize avionics repairs for the F-16 in order to maximize the probability

<sup>46</sup>Embry, 1985, p. iii.

<sup>47</sup>Ibid., p. v. This source refers to OMB Circular A-76 (revised).

of achieving weapon system availability goals across bases, with priorities changing biweekly to reflect current asset positions worldwide. Such a system enhances the readiness and sustainability of weapon systems by virtue of its short-term planning horizon, its access to current asset status, and its reflection of the inherent uncertainty of failures in high-technology weaponry during peacetime and war.

EDI enables these responsive repair initiatives to be extended to contractor repair, thereby making such repairs more closely reflect the dynamically changing efforts of the services to keep weapon systems usable. Currently, contractor repair is typically scheduled four times yearly on the basis of forecasts using older data. When high priorities for certain repairs surface, they are handled on an ad hoc basis using phone calls and facsimile (FAX) communication. If a repair contractor were connected to its service customer by EDI, dynamically changing priorities could be handled far more systematically.

As an example, if a service's repair priorities were recalculated weekly, a new repair priority list could be sent to a repair contractor automatically together with a similar list generated for organic repair. This list, which would tell the contractor what to repair first and list target (or even required) completion dates, could automatically interface with a contractor's internal repair scheduling or management system to facilitate timely repair.

Such a change could have the same effects as have similar changes in organic repair, which have been documented in several studies to have enhanced readiness and sustainability. One such study showed that a management process making use of an organic repair system could increase weapon system availability by some 6 percent after a 30-day (simulated) war.<sup>48</sup> Another study, conducted for the Army, showed similar gains as well as significant opportunities to maintain current readiness and sustainability while reducing the number of assets available worldwide or reducing repair capacity.<sup>49</sup>

Potential gains from more dynamic control over contract repair are most likely to be derived when repair cycles are relatively short and the process is somewhat flexible. By contrast, single-purpose test stands, a lack of cross-trained technicians, prohibitively long setup times to begin certain repairs (e.g., shutting down a normal production line), or contracts whose narrow scope prohibits tradeoffs between repairs would make it difficult for a contractor to shift repair resources among DoD components. This last circumstance applies to

<sup>48</sup>Forthcoming RAND research for the Air Force.

<sup>49</sup>Boren et al., forthcoming.

the many DoD repair contracts made with subsystem manufacturers, who can repair their own component but no others. EDI could be used systematically to speed up or slow down such repairs without prioritizing *what* will be repaired.

Thus, potential EDI gains appear most significant in this target area when a repair contractor:

- Repairs critical weapon system components for which repairs must often be expedited and serviceable assets shipped to different locations;
- Has a broad scope of repair for DoD components; and
- Has a repair process that can be dynamically changed—i.e., speeded up, slowed down, or changed in mix.

Even where EDI gains appear significant, however, at least two prerequisites must be fulfilled: costs must be reasonable, and contractors must be willing to accept a more dynamic repair schedule. In the first area, more dynamic directing of contractor repairs may increase contractors' costs, but where repairs are not needed soon or at all, actual costs may decline. Of course, any increases in repair costs must be weighed against the resulting increases in readiness and sustainability.

That contractors must be willing to accept a more dynamic schedule is not as trivial a prerequisite as it might appear. Some repair contractors have a great deal of bargaining power with DoD, largely because they are often the sole-source providers of specific repair capabilities, because switching costs are high, and because shortages of any part can prove disastrous. Moreover, the sole-source capacity of certain contractors is only partially a function of their frequent ownership of proprietary technical data packages needed to conduct repairs; the relatively specialized skills and experience of repair technicians also place these contractors in a strong negotiating position.<sup>50</sup> All of these factors serve to outweigh the potential counterbalance that the government itself would be in a strong position because it has a great deal of buying power.

<sup>50</sup>Embry, 1985, p. viii.

### Transportation

EDI enables DoD to extend its current internal visibility over shipments into the "external pipeline" and, further, allows for control over shipments in this pipeline. Loads can be speeded up, diverted, or even delayed or slowed when changing demands or circumstances so dictate. Although shipments can now be controlled through use of ad hoc techniques for high-priority demands, DoD users rarely do so because there is little peacetime need for such actions. Not surprisingly, in a four-week period at MCLB, Albany, no such exceptions occurred.

During a contingency or wartime, the need for such dynamic changes is more likely to occur for several reasons:

- Sudden changes in the location of the shipment's recipient unit;
- Changes in the unit's size or mission owing to damage or shifts in tactics, creating a need for pending shipments;
- Congestion in transportation channels or transportation nodes (private or DoD);
- Unexpected damage to transportation channels or nodes; or, finally,
- Changes in shipment priorities.

There are no quantitative estimates available on how many such changes would actually be made during a contingency or war. Nonetheless, USTRANSCOM, the DoD agency charged with coordinated transportation during wartime, and others studying DoD distribution capabilities<sup>51</sup> have assumed that such dynamic changes will be an important new tool with which to make DoD transportation and distribution systems more adaptive to uncertain conditions in wartime.

EDI's procedure for tracking and dynamically controlling shipments in carrier's hands could begin when a carrier picks up a package from a DoD shipping point. The shipping point would subsequently send the government bill of lading (GBL) or a comparable document in EDI format to the carrier, who would then electronically track the shipment through various intermediate nodes using its own internal system. A shipment's status would be updated in the carrier's internal system roughly every six to eight hours or even more

<sup>51</sup>For example, the ongoing RAND Corporation research project for OSD on DoD's future distribution system.

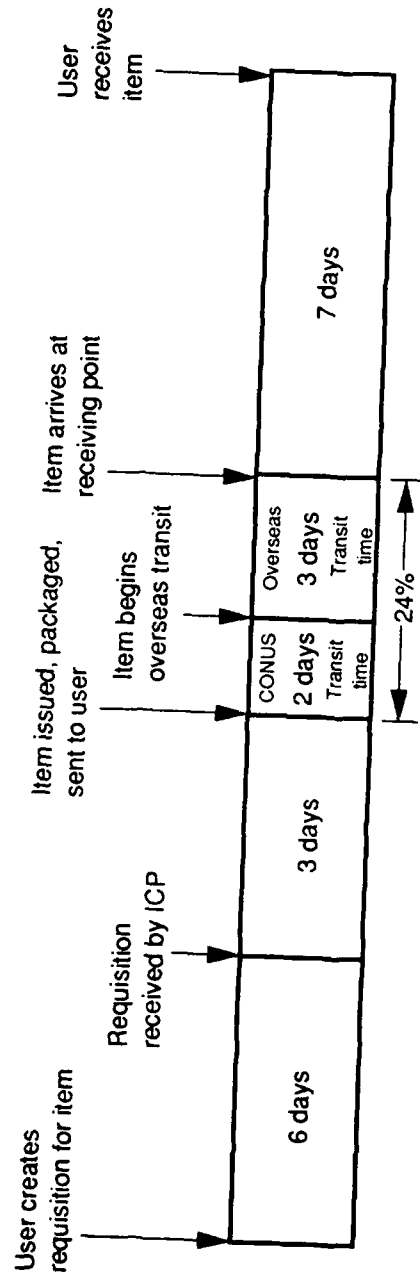
frequently; DoD could thus receive shipment status for any individual shipment or group of shipments at any time. When a DoD transportation manager or the shipment's recipient needed to divert a package with a carrier, it would send an EDI transaction to that effect.

How great might be the logistics gains for such a new capability? To estimate gains, we turn to the logistics pipeline from item requisition through receipt by the user, as shown in Figure 3.2. This pipeline of high-priority transactions going overseas by air reveals that the time a requisitioned item is actually being shipped is actually only five days, or 24 percent of the 21-day pipeline. Roughly 85 percent of all DoD cargo is shipped by commercial carriers, so five days is roughly the amount of time an item is in the "external pipeline" and is thus potentially controllable with EDI. In short, then, dynamic control of this segment alone affects only a relatively small portion of a requisitioned item's pipeline time. DoD's internal systems more or less provide visibility of an item's position and status while that item is in the "internal pipeline," which absorbs the majority of the time it takes to move a requisitioned item to the end user. Nonetheless, EDI allows for control over, as well as visibility of, a high-priority shipment for an additional five days. A sudden surge in demand owing to a contingency or to war could make this increase in control critical to readiness and sustainability.<sup>52</sup>

Several prerequisites must be fulfilled for this EDI benefit to be gained. The most important of these are (1) the carriers' ability to track in-transit shipments and to report the status of such shipments to DoD in a timely manner; (2) DoD's ability to decide when diversions are necessary; and (3) the carrier's and DoD's joint abilities to make diversions occur systematically.

Although the first prerequisite outlined above is the closest to being met, the maturity and use of standards vary according to transportation mode. Specifically, rail and motor carriers are far along, followed by air—whereas ocean carriers lag behind both but are developing standards now. Nonetheless, X12 transaction sets now in use can ask for and report shipment status to shippers. DoD is heavi-

<sup>52</sup> Parenthetically, this pipeline illustrates that having transactions in standard electronic formats alone will not necessarily make actions move fast. DoD has long used standard electronic formats for requisitions to release orders; yet 76 percent of the pipeline is still absorbed creating and handling these transactions. These transactions move between decision points during this time and await electronic updating cycles during these days. Of course, they would likely have taken much longer without electronic formats.



NOTE: Total pipeline time is distributed over MILSTEP segments proportional to their individually reported lengths. MILSTEP Segments, Averages, Overseas, Air, FY89.

Fig. 3.2—DoD-wide logistics pipeline overseas, immediate ICP availability, TPG 1, FY89

ly dependent on private motor carriers, and 14 of the top 22 DoD motor carriers, representing 38 percent of DoD CONUS shipments, had invested in EDI by 1987.<sup>53</sup> Unfortunately, these carriers were more likely to have implemented the EDI invoice transaction set than those for status reporting.<sup>54</sup>

The second prerequisite is more difficult to meet than the first. To decide when diversions are needed, DoD decisionmakers must be aware of changing users' requirements and must be able to determine when congestion exists or to anticipate future congestion down the pipeline—capabilities that must be built into DoD internal management and control systems. Moreover, without the help of an electronic agent to monitor EDI transportation status transactions by channels or nodes, the visibility provided by the EDI status messages will be practically useless as agents will have to combine visibility across services and carriers. USTRANSCOM is now prototyping a system that would link status transactions across carriers.

The third prerequisite—the ability to make diversions automatically—is also difficult to meet, for it would appear that the relatively few private sector firms that routinely receive electronic transaction status reports from carriers currently monitor these reports by hand rather than by means of an electronic agent. More commonly, a shipper or receiver queries a carrier's system regarding a specific shipment, and if an in-transit shipment needs to be diverted or expedited, the carrier is contacted by phone, facsimile machine, or electronic mail. Given the need during a contingency to track and divert or expedite perhaps thousands of shipments, DoD may need to take the lead in developing this missing link.

Electronic links with carriers are facilitated by the cultivation of long-term relationships with carriers, as such carriers have an incentive to develop the capabilities DoD needs. Guaranteed freight agreements are an available contractual means of providing this continuity. Where DoD has implemented EDI in transportation to date, guaranteed freight agreements have been used along with EDI capabilities as a DoD condition of acceptance for such contracts. Whether this introduces an unnecessary barrier to doing business with DoD will be discussed in Section IV.

An important indirect effect of receiving transportation status transactions from carriers is the ability to monitor carriers far more dynamically and systematically than is now possible. (Currently, per-

<sup>53</sup>Heard, 1988, p. C-2.

<sup>54</sup>Ibid.

formance monitoring is essentially based either on complaints regarding late shipments from receiving points or on "no shows" at shipping points.) With EDI status transactions, transit times can be readily monitored by destination against contractual performance guidelines.

Although MCLB, Albany, did not use status transactions to divert or even to monitor shipments, it did aggregate its transactions, thereby enabling performance to be analyzed over time. The results of such an analysis of 1,720 shipments showed that the performance of the carrier—a good performer for MCLB, Albany—varied considerably by destination. The average shipment to California (the destination for 13 percent of shipments), for example, arrived on time, but the average shipment to the next most common destination, Florida, took twice as long as the contractual guideline dictated. The data further showed that the average shipment to 37 states exceeded the guidelines by at least 11 percent, and shipments to those states accounted for 72 percent of sample shipments. Clearly, the ability to monitor performance enabled by EDI, together with the ability to adjust contracts, improve performance, or change carriers, could provide DoD with substantial leverage in its efforts to encourage better carrier performance.

### **Supply and Procurement**

The use of EDI to reduce stock levels, discussed in target one, also offers buyers tighter control of vendor behavior—that is to say, more control over the delivery of items purchased. As previously discussed, private sector firms use EDI most often to place orders against contracts in efforts to ensure that such orders are received just when they are needed. In this way, these firms are using EDI to dynamically control their suppliers' actions. The more sophisticated firms thus manage to receive their orders precisely at the time they are needed in production and in the correct order.<sup>55</sup> Retailers similarly use EDI in "quick response" systems, which enable suppliers to deliver "floor-ready" packaged units of merchandise in response to electronically generated orders based on detailed retail sales data. EDI can thus reduce the time needed for supply functions while also reducing storage and handling costs.

<sup>55</sup>In manufacturing, this is sometimes referred to as STLSS, or shipments to line set sequence. Shipment quantities and arrivals are matched to the timing of manufacturing lines.

As described in the discussion of the first target, DoD can achieve at least some of these gains for commodities bought directly for requisitioners and for predictable production lines—e.g., for scheduled overhaul programs or even ammunition manufacturing. Where procurement or delivery lead times are long and demands are unpredictable, however, such an approach will not be feasible.

As described above, DoD already uses indefinite delivery contracts to arrange some vendor deliveries, but these deliveries are sometimes made to wholesale points rather than to the requisitioner. EDI can simply augment such arrangements by enabling delivery orders to flow to requisitioners automatically without human intervention when certain parameters are met. POPS, DLA's EDI-like system, does this with several dozen vendors. Unfortunately, no data exist showing how much time such arrangements save.

Where they exist, the cross-vendor supply availability databases described above will facilitate these improvements. The more visibility DoD has of vendor stocks, the more likely it can depend on them instead of maintaining internal stocks. (Of course, if the vendors over which DoD has visibility typically buy or manufacture on demand, low or no stockage will not be an indication of the ability to respond to demands quickly.)

Parenthetically, the extended use of such arrangements could help address DoD's capacity problems with warehouses. DoD warehouses are designed to be managed efficiently at 85 percent utilization, but today they are operating at roughly 91 percent capacity, and some are being closed.

There is one critical, four-pronged prerequisite to the reduction of supply pipelines with EDI-facilitated direct vendor deliveries. Specifically, vendors must be willing to provide such deliveries in the quantities needed (typically smaller than those they would make to wholesale points), without prohibitive price increases, within acceptable time frames, and packaged as required. This is most likely to occur when the vendor already has a national (or even an international) distribution network that DoD can simply tap. Given occasional small orders below vendor limits and the importance of being able to respond rapidly in a surge, however, DoD will not be able to exploit this EDI-facilitated benefit as fully as will the private sector.

One further way in which EDI can be used in procurement to dynamically control vendor actions lies in the electronic monitoring of actual vendor shipments of goods DoD has purchased. Even when "award-ship time" (the time between vendor receipt of a DoD award for an item and when the vendor actually ships the item) does not in-

clude production time—i.e., when the item does not have to be specially manufactured after the award—this segment is troublesomely long. DLA DPSC's direct-vendor delivery items serve as a useful example: award ship times for such buys between October 1987 and March 1989 averaged 35 days out of a total pipeline of 113 days from requisition to user receipt. DLA attempts to control this segment by requiring vendors to make shipments within set limits by priority (10, 30, or 45 days) and by relying on those on the receiving end to report delinquencies. For a sample of SPEDE buys, award-ship times averaged 18 days and vendor identification was a better predictor of the segment time than priority.

Given an electronic agent, EDI could be used to receive shipment notices from vendors and automatically monitor vendor compliance against requirements. If a vendor was late, an EDI transaction could automatically be issued to follow up on that vendor and to maintain records on its performance. Hence EDI, coupled with well-designed agents, could tighten the monitoring of this troublesome segment and, where vendors did not respond, could monitor poorly performing vendors for future buying decisions.

#### **TARGET: GAIN SHORT-TERM, ACCURATE "HEADS UP"**

The fourth target for EDI lies in its use as a means of providing a short-term, accurate "heads up"—i.e., warning—to actors within the pipeline. If pipeline actors can use this warning to anticipate work and to plan more effectively, they will be better able to manage their pipeline segments by shortening them or by adjusting their tasks more dynamically to meet demands. This capability can affect the transportation and maintenance and repair pipelines discussed below.

#### **Transportation**

There are two instances in which a "heads up" to pipeline actors may enhance pipeline performance:

- The transportation management office (TMO) could give carriers advance shipment information so they could pick up shipments faster or route their loads more efficiently.<sup>56</sup>

<sup>56</sup>In MILSTEP, this TMO function is part of the depot hold segment.

- Carriers could give consignees warning when shipments were about to arrive.

The first potential opportunity does not appear to be a worthy target during peacetime, since this task takes only 12 hours to accomplish DoD-wide. Once a DoD shipping point commits a load to a carrier, the load is picked up within a day. During wartime or a contingency, however, this "heads up" might prove more useful, since loads from any one shipping point might increase dramatically. One day's demand at MCLB, Albany, during a major contingency, for example, might constitute 46 percent of that center's *annual* workload. Under such circumstances, carriers might not have sufficient equipment to respond as quickly to DoD demands and thus could use advance shipping information to divert their equipment or to change routes.

A critical prerequisite to such a gain lies in the ability of transportation carriers to receive such information via EDI *and* actually use it. Few carriers, large or small, now use an electronic advance shipment information transaction, and most do not have the capacity to take advantage of such information in electronic form.<sup>57</sup> Further, a DoD pilot test of EDI in transportation indicated that DoD shipping points cannot provide accurate advance shipping information to carriers.

The second target for providing a "heads up" to pipeline actors appears potentially more useful. As shown in Figure 3.1, the receipt take-up segment of the transportation pipeline—i.e., the time between receipt of a shipment at a shipping point's loading dock and its eventual receipt by the requisitioner<sup>58</sup>—stands out as a significant portion of the pipeline. Indeed, when measured separately for high-priority shipments overseas for items immediately available from the ICP, this segment takes an average of 10 days, or 32 percent of the time between a requisitioner's demand and receipt of the item.<sup>59</sup> Some of this time may result from delays in the recording of items in stock records, but even if this accounted for half the time, the receipt take-up process remains a troublesome delay in the logistics process. The problem is at least partially caused by receiving points' reactivity. Specifically, when loads arrive, they are handled as well as possible—

<sup>57</sup> Heard, 1988, pp. C-1, C-2.

<sup>58</sup> When the item is entered in the local stock records.

<sup>59</sup> This differs from the seven days shown in Figure 3.2 because the figure shows the relative distribution of the average pipeline time of 21 days across segments. Because not all segments are reported for all transactions, segments measured separately have different lengths.

but sometimes many arrive at once, and backlogs form. In other cases, loads may have one or two higher-priority items in them that are not obvious when a full truck or container arrives. During war or contingencies, stories abound of units sending their own representatives to receiving points to find shipments they need quickly.

If receiving points received transaction status reports on pending shipments and could see the arrival times of particular shipments, they might be able to manage their equipment and manpower more efficiently and deliver at least high-priority items to their users more rapidly. The shipping point could sort out when pending shipments were arriving, what parts of them were especially important to expedite (many are consolidated), and which required special handling—e.g., special equipment. End users could even be given a “heads up” that their important shipment was about to arrive so that they could arrange to have it picked up immediately. This capability could be combined with DoD’s freight bar-coding system, LOGMARS (LOGistics application of automated MARKing and Reading Symbols), to speed shipments to users even more.

Although this potential use of EDI appears especially beneficial, it has several prerequisites that currently cannot be met. First, carriers must be able to recalculate expected arrival times for shipments “on the fly” as a shipment passes intermediate handling points—something they typically cannot do. Second, receiving points need an electronic agent to sort through the hundreds or even thousands of transaction status reports and translate them into usable information on which to act. For example, the agent could construct daily receiving lists highlighting shipments that need expediting or special handling.

Yet another prerequisite to this EDI application is the timely arrival of GBLs prior to actual shipments. The electronic agent would need to match the details provided on the GBLs with the carrier’s transportation control numbers to determine the actual end recipients of the many shipments within a consolidated load and hence to ascertain their priorities. This part of the puzzle is actually in place—or nearly so—at several DoD receiving points involved in the DoD EDI transportation pilot. Without this electronic transmission of GBLs, receiving points are often in the dark about a load’s contents even after it arrives, for their hard copy of the GBL sent by the shipping point often arrives *after* the load itself. (In MCLB, Albany, this occurred 42 percent of the time during our test sample.)

The design of this critical means of exploiting transportation status transactions to improve receipt take-up is not, to our knowledge, in-

corporated into any current or planned DoD transportation management systems.

### **Repair**

The third target area discussed above included the use of EDI to control contractor repair actions more dynamically via prioritization and completion schedules. EDI enables those managing repairable items within DoD to have electronic visibility of the status of assets at a contractor. With EDI, item managers (IMs) could receive a "heads up" when repairs were almost completed or when assets were judged to be serviceable. In this way, these items would become manageable assets at the IMs' disposal. Rather than having to wait for the assets to become visible in a DoD supply system or calling the contractor, IMs could thus "see" assets soon to be available for distribution and actually send electronic material release orders to the repair contractor for assets emerging from repair.

Some DoD repair contractors already provide visibility to IMs of the assets under their control by various means—e.g., hard-copy reports, required electronic reports to account for government-furnished materials, or even on-line access to internal contractor systems overseeing the repair process. Hence, in many cases, electronic links already exist. Use of EDI along with a carefully designed electronic agent to translate information into usable form (e.g., projecting asset availability on the basis of repair cycle times or summarizing assets available for immediate release) would allow such information to be more systematically available for IM usage from many repair contractors. This new control would be especially helpful in the high-technology repairable arena, where individual components are worth tens or even hundreds of thousands of dollars.

Similarly, EDI could be used to provide repair contractors with an electronic "heads up" when unserviceable assets were on the way to them for repair.

### **TARGET: BETTER HANDLE SURGES IN DEMAND**

During wartime or a contingency, sudden and unpredictable surges in demand are inevitable but can cause congestion and gridlock in transportation systems together with backlogs in procurement, supply, and repair. Hence, visibility *and* management of flows of items through logistics pipelines are both needed to enhance logistics effec-

tiveness. Potential ways in which EDI can contribute to such capabilities have been discussed above. In summary, EDI could:

- Tap external sources of supply and allow vendors to identify themselves via bulletin boards, cross-vendor databases, or even broadcast systems;
- Provide visibility in transportation pipelines to divert loads toward the goal of averting congestion and meeting changing priorities;
- Provide advance shipping information to carriers so that they could divert their equipment and reschedule trips to meet DoD demands more rapidly; and
- Provide a "heads up" to receiving points to help sort out consolidated loads more quickly such that high-priority cargo could be located and expedited, thereby reflecting changing priorities.

EDI coupled with agents and modified internal management systems can improve responses to surges in demand in yet another important way. Specifically, the manner in which EDI transactions are handled during a surge can be changed more systematically by allowing *logistics systems* rather than *logisticians* to respond to surges.

An example is warranted. During a declared war, procurement and transportation rules change; some procedures are waived while others are added. A set of supply contracts for thousands of critical war reserve items are activated. Relief from a wide variety of time-consuming procedures has been planned, but notifying all actors of the emergency provisions and putting the provisions in place is a cumbersome process.

Systems generating electronic transactions could be designed with electronic "gears"—e.g., for peace, intensive surge, or national emergency. When gears were changed, rules in the system would automatically change as well so that managers throughout DoD could respond more rapidly. For example, RFQs in peacetime might automatically switch to orders if full and open competition requirements were waived, and debarred or suspended vendors could automatically be reinstated as sources of supply (an emergency provision). Similarly, time allotments in electronic systems receiving quotations via EDI could be radically shortened, and purchase requests could automatically be filled from multiple sources where no single source could fill them completely. Further, advance shipment information capabilities could be "turned on" to alert carriers of

pending surges in transportation demands, and preestablished electronic links could activate wartime contracts to facilitate order placement and production monitoring of critical items.

But what about the more likely surges in demand for contingencies where no major procurement or logistics rules are changed—cases in which DoD will have neither the time nor the permission to turn to a different set of vendors? EDI-facilitated logistics tools could be designed to adjust as peacetime regulations and statutes allow, rendering many of the aforementioned system changes feasible in such circumstances. For example, bulletin boards similar to that of NSC Jacksonville could easily expand to post more RFQs and, if designed to operate under surges in demand, would be less likely to “choke” than would a paper-based transaction system, as it would already be in position to tap a wider set of vendors.

In short, EDI is a necessary but certainly not a sufficient technique to improve responsiveness during surges in demand. Internal DoD systems producing the EDI transactions and the electronic tools used by DoD with EDI transactions must be designed with such “gears” built into them. To date, however, no such capabilities appear to be planned for DoD's EDI uses.

#### **EDI'S EFFECTS ON THE ACCURACY OF LOGISTICS ACTIONS**

Lists of EDI's benefits usually include reductions in data entry errors and data entry costs. Certainly EDI enables external logistics-related business transactions to be electronically produced from internal systems, thereby eliminating rekeying of transactional information onto or from hard-copy forms into a vendor's internal systems. This can significantly improve the accuracy of business transactions—e.g., logistics actions—if:

- EDI is implemented to eliminate data entry on the sending or receiving end or both; or
- Data entry errors significantly affect business actions owing either to their high volume or to the serious consequences of an individual error.

These conditions are often not met. For example, EDI transactions are sometimes created from hard-copy documents rather than from electronic files—or they are received electronically but are rekeyed

into an internal system. In MCLB, Albany, at the time of our review, EDI transactions were indeed created from electronic files—but these files resulted from data entry of information for GBLs keyed into an automated system by hand after transportation arrangements were made. Similarly, most SPEDE vendors reported that they usually printed out or hand-copied the electronic transactions they received from DPSC to internal systems to produce invoices. Hence, in most such cases, data entry on the receiving end was not reduced.<sup>60</sup>

Second, error rates due to data entry are not available for DoD logistics systems in general, so potential gains to be derived from their reduction cannot be estimated. In the MCLB, Albany, and SPEDE cases, no such errors were measurable in the sample data analyzed. Many data entry processes now incorporate various error-checking techniques and other aids to reduce data entry errors. These techniques are often set up to prohibit errors in certain fields to be keyed, so important errors are caught during the keying process itself before they result in erroneous transactions or actions. For example, the data entry process for GBLs at MCLB, Albany, prohibited the entry of duplicate GBL numbers and automatically incorporated vendor addresses when a vendor code was keyed. As a result, data entry errors were an insignificant source of logistics errors even though EDI did not reduce data entry.

Data entry errors do occur, however, and in high-volume or especially costly or sensitive processes even a very low error rate can cause significant problems. In such cases, EDI may provide a way to solve these problems. For example, a major freight company using EDI reported that it paid for the cost of developing an EDI system with the savings from error reductions alone.<sup>61</sup>

EDI may have a more significant effect on reducing errors caused by transactions handled by phone and transcribed by the caller either to an automated system or to a paper form. Again, no measure of the frequency of such errors exists, but 71 percent of SPEDE vendors reported that they thought the electronically based SPEDE system was more reliable than the traditional phone-based bidding process.

<sup>60</sup>Mail survey of 42 active SPEDE vendors, December 1989 to January 1990. Response rate: 69 percent.

<sup>61</sup>Logistics Management Institute (LMI), undated, p. 7.

#### **IV. WHY POTENTIAL EFFECTIVENESS GAINS HAVE NOT YET BEEN REALIZED**

In Section III, five target uses of EDI to enhance logistics functions are identified, but in few cases could instances of actual gains from EDI in these areas be cited. This raises three questions. First, if these target areas have such potential to enhance logistics, why aren't the benefits evident? After all, DoD is already using EDI in dozens of locations across logistics functions. Second, does this lack of evidence constitute proof that such targets are invalid? Third—and charitably—are the targets valid but too far from existing DoD management and technological capabilities to yield any gains in the near future? This section suggests that the answers to the last two questions are negative and that the potential gains identified in the five previously outlined target areas have not yet been realized for five critical but surmountable reasons:

1. Most early DoD efforts to use EDI have focused on improvements that do not affect the logistics pipeline or on establishing the technical feasibility of EDI—or such efforts are simply not far along.
2. Even where EDI has been used in logistics target areas, it has not yet been fully exploited as a tool to do work differently; nor has it been designed and implemented to fully achieve the potential gains outlined in these target areas.
3. Links are weak between DoD's EDI applications and internal logistics systems and those of vendors.
4. Current DoD EDI efforts are hampered by uncertainty regarding the impact of EDI on small business and competition and regarding the legal and regulatory status of electronic business transactions.
5. Standards, software, and network approaches are incomplete and tend to reflect paper-based methods.

Each of these obstacles is discussed below and is prefaced by a brief discussion of those obstacles confronting private sector EDI users.

This section is not intended to provide an exhaustive list of regulatory or statutory obstacles; instead, it seeks to identify the most critical obstacles that must be surmounted in order for potential en-

hancements to logistics to be realized. More technical aspects of obstacles relating to software, technical, and electronic network issues—both for DoD and for vendors—are addressed in Section V.

### DoD IS NOT ALONE IN FACING OBSTACLES TO EDI'S GAINS

It is difficult for any organization—even one far less complex than DoD—to achieve gains from a new technology application such as EDI. The implementation of any new technology is a difficult task, but EDI is even more difficult to implement because of the cooperation that it necessitates across many independent enterprises. In fact, despite the many reports of the thousands of private firms that currently use EDI,<sup>1</sup> most gains have been reported from EDI only after fundamental changes have been made in business practices and trading partner relationships. Many companies in a recent survey of EDI users, for example, were unable to answer whether EDI had brought them net benefits, but almost three times as many reported that, so far, EDI was a net cost. This is not surprising, however, given that these firms' up-front investment had not yet been spread across many transactions. A significant number were still using EDI in a pilot stage, and 75 percent reported trading with fewer than 50 partners—with half of these having fewer than ten trading partners.<sup>2</sup> (DoD buys from at least 30,000 to 50,000 vendors annually!) Reported efforts to achieve greater benefits included plans to change internal policies and procedures as well as trading terms and conditions with partners, such as the use of favored-supplier status.

In short, although close to half of the EDI users who responded to this survey viewed EDI as a "business necessity," surveyed firms conceded that they derived little gain from EDI until they changed their

<sup>1</sup>There are several estimates available from private market research firms of between 5,000 and 7,000 firms or even up to 10,000 firms. See, for example, TDCC, 1989, which contains estimates of 4,000 firms worldwide (p. 37) and 10,000 firms worldwide (p. 33). Wright, 1989 (p. ix), reports that a survey by the market research firm INPUT found that 34 percent of "Fortune 1,000-class public and private firms, large universities, and government agencies" now use EDI, and an additional 20 percent are actively planning to use it. Masson and Hill, 1989 (p. 16), reported the results of a 1989 survey with respondents having median sales of \$180 million. They found that 17 percent of these firms used EDI. A total of 52 percent used EDI or reported planning to do so within two years.

<sup>2</sup>TDCC, 1989, p. 7.

work practices.<sup>3</sup> This bleak picture does not imply, however, that DoD should postpone the introduction of EDI until the private sector has mastered it, because this strategy would leave DoD out of the many important decisions that would be made as U.S. industry adopted EDI—decisions that would directly affect EDI's benefit to DoD. Given the level of interest and work in EDI in the private sector and the increasing number of firms using it, DoD is correct in mandating the use of EDI as the way of doing business in the future. This mandate should also facilitate a speedy, well-planned transition to EDI, and eliminate the high costs that a lengthy transition period of duplicate systems would entail.

Now we return to the discussion of why this goal is so difficult.

#### **MOST EARLY DoD EDI EFFORTS HAVE NOT FOCUSED ON TARGET AREAS**

One reason logistics performance has not been enhanced as proposed in the target areas in Section III is that few DoD EDI efforts to date have focused on these areas—and the few that have done so are not far along. Of the dozens of EDI applications now being planned, prototyped, or used in DoD, most are focused on electronic payments (electronic funds transfer, or EFT), invoicing, or transmission of mandated reports (e.g., audit reports, cost analyses, or hazardous waste tracking reports). These efforts may result in substantial savings to DoD, but none will directly enhance logistics performance as identified in the target areas in Section III.<sup>4</sup> For example, efforts to implement EDI at dozens of DoD shipping and receiving points currently focus primarily on laying the groundwork for future electronic invoicing and payment.

Furthermore, most DoD EDI applications in logistics functions are still at a "proof of principle" or prototype stage. For these applica-

<sup>3</sup>Ibid. The research reported in Benjamin et al., 1989, corroborates the point that private firms are increasingly implementing EDI as a "competitive necessity" and that benefits come only after work processes themselves are changed. This article provides a particularly useful discussion of the challenges of gaining benefits from EDI.

<sup>4</sup>Indeed, EFT promises substantial savings for DoD not only in postage but in a reduction in the penalties now paid to vendors when DoD cannot pay invoices within 30 days. In FY89, such penalties for DoD totaled \$14 million. DoD's efforts to use EFT are directed to reduce or even eliminate such payments. Of course, EFT will speed up only the very end of the payment pipeline. Without efforts to speed the flow of invoice-related information (e.g., receipt documents, GBLs, purchase orders to match to the invoices, and the invoices themselves), the payment cycle cannot be substantially shortened. This is a major reason DoD has focused on the invoice process.

tions, gains still lie in the future. For example, USTRANSCOM (via MTMC) has developed a prototype of in-transit visibility to demonstrate that such visibility can be achieved through use of EDI across varied networks—but no electronic agent has yet been developed to enable transportation managers at USTRANSCOM, MTMC, or the many DoD receiving points to use these data to better manage their workloads.

There are, in fact, several EDI prototypes or operational systems in functions affecting logistics pipeline performance, including a few bulletin board systems as well as SPEDE, POPS, and major efforts with brand-name subsistence vendors and fuel providers. The following discussion of obstacles suggests why target-area gains are not dramatically apparent even in these areas.

#### **EDI HAS NOT BEEN FULLY EXPLOITED TO DO WORK DIFFERENTLY**

Probably the greatest obstacle to the achievement of EDI enhancements to logistics lies in the fact that DoD has not yet fully exploited EDI, even in the target areas, as a tool to do work differently, and has not yet designed or implemented EDI applications for the achievement of potential gains in these areas.

Yet this obstacle is encountered whenever a new application of technology is introduced in an organization, be it public or private. *How* a new technological application is implemented in a work setting, in other words, affects the likelihood of its success more than any technical or organizational characteristics of the application itself.<sup>5</sup>

When one has a new tool such as EDI, it is sometimes difficult to see where it can be used to its greatest advantage and what form a given application should take. One can use the handle of a screwdriver, for example, to pound in a nail, and because it works, one might declare that application a "success"—but clearly a screwdriver works better on screws. So too may managers use EDI, a technique that has been widely publicized as beneficial, to less-than-optimal ends. Such managers may thus fail to recognize that further changes in the way they work might yield greater gains.

Furthermore, managers may assume that EDI has achieved benefits such as, for example, a reduction in pipeline times when in fact

<sup>5</sup>Bikson et al., 1987, pp. 12, 17.

such times were already insignificant or when EDI has actually slowed pipeline times because of the way in which it has been implemented.

These problems are exacerbated by the fact that the effects of EDI are often not well or easily monitored. Effects will vary across time as work procedures are adapted, new uses are found, and more vendors participate. Moreover, EDI can affect different levels and subunits of an organization in different ways. Workloads may shift, for example, with some units showing gains in productivity while others experience losses. Hence, some work areas may consider EDI a success while others deem it a failure. Even if an overall DoD objective is achieved—e.g., when a logistics pipeline is speeded up—simultaneous reductions in productivity at a subunit level may lessen the overall net improvements achieved unless work changes are made.

Potential benefits of EDI (or any new application of technology) may not even be identified and pursued at the outset because work itself must change to achieve them. As experience with EDI grows, unanticipated and innovative uses may thus reap unexpected benefits. Conversely, unexpected costs may also appear.

These implementation and design problems are evident in various DoD EDI applications. Examples abound of these challenges to achieving potential enhancements to logistics functions. Most can be corrected through changes in the design or implementation of the EDI application. As examples:<sup>6</sup>

1. According to users, SPEDE sometimes actually slowed PALT for high-priority transactions because without it these orders might have been placed by phone or might have been placed electronically but without competition within regulatory bounds. Because of SPEDE's design, all RFQs wait five days for responses regardless of their priority. This system could be changed to permit dynamic adjustment of required RFQ response times by vendors to within 24 hours or even less, as is done by phone for high-priority buys.

<sup>6</sup>These examples are based on the status of the EDI applications in mid-1990. They are not meant to imply that these EDI applications have not benefited DoD or that they should be abandoned. Rather, they are meant to demonstrate that even EDI applications that are considered successful have the potential for even greater benefits to DoD if their design and use are adjusted to focus on enhanced logistics outcomes in the target areas. Several examples apply to SPEDE and to the use of EDI by MCLB, Albany, because these were the two EDI cases analyzed. Some of the examples are addressed in plans for enhancements to these applications.

2. No EDI procurement application (for goods or transportation services) now used by DoD has "gears" designed to allow procedures to change during a contingency or a mobilization, as suggested in target five. For example, SPEDE cannot shift to an order placement process for FAR-permissible buys (buys under \$2,500) despite the fact that 98 percent of its buys to date have been under this limit.<sup>7</sup> Even in peacetime, then, such an order placement facility could be used within the FAR to shorten PALT when necessary. (PALT under SPEDE is already very low, of course, but could lengthen during a surge in demand.)
3. In MCLB, Albany, EDI enables the shipping point to track shipments and vendor performance against delivery guidelines by destination via daily on-line shipment status reports. Unfortunately, those that track shipments do not use these status reports. (They call the carrier if necessary, rendering the status reports irrelevant.) DoD receiving points have neither convenient access to the reports nor any means of analyzing them. Furthermore, although vendor performance is tracked by means of the status reports, those responsible for tracking performance do not use the reports to improve performance.
4. As discussed in Section III, SPEDE is not designed to facilitate close monitoring of vendor shipment times. Instead, vendors are allowed to be delinquent in shipping items 15 days *beyond* the grace period of 15, 30, or 45 days (depending on priority) before SPEDE even defines them as "delinquent." Moreover, the system does not easily provide automated tools with which buyers can follow up on these vendors or prevent troublesome vendors from simultaneously receiving more awards. Hence, a potential benefit of the application to shorten a significant pipeline segment is forgone.
5. SPEDE unnecessarily mirrors a paper-based system by soliciting only three vendors for each RFQ, thereby essentially eliminating large firms. (In the small and well-identified

<sup>7</sup>On the basis of a sample of SPEDE awards from January through June 1989, the SPEDE median award was found to be \$123, with an average of \$38. The median price of an individual item purchased was \$24. Ninety-two percent of all SPEDE buys were under \$1,000, the limit for the Walsh-Healey Act. The highest buy was \$16,800 and the lowest \$8.

medical supply market in which SPEDE now operates, this appears to neither inhibit competition nor to lengthen PALT—but as SPEDE is expanded to buying environments as DLA plans, it may become a significant obstacle to shortening PALT.) In a paper-based world, limiting solicitations to three vendors makes sense because of the relatively high cost of adding vendors. As EASE has demonstrated, however, EDI allows for simultaneous solicitation of multiple vendors at essentially no extra cost. In SPEDE's current environment, artificially limiting solicitations to three vendors at a time slows PALT because if two of the three vendors do not submit quotes, the RFQ must be reissued in a new five-day solicitation cycle.<sup>8</sup> This design characteristic could slow PALT much more during a surge in demand, where it may be necessary to make thousands of purchases quickly.

Furthermore, excluding large firms from SPEDE competition (those with and without federal supply schedules [FSSs]) may actually increase prices and conflict with the FAR, for the FAR stipulates that buys under \$25,000 should be set aside for competition among small businesses when the resulting price will "be competitive in terms of market price, quality and delivery."<sup>9</sup>

In the past, there has been no fast and convenient way for contracting officers to determine what a true market price would be across all firms. Hence, if at least two quotations were received from small businesses, the lower of the two was generally considered the market price.<sup>10</sup> EDI now enables DoD contracting officers to solicit small businesses, large businesses, and those on FSS simultaneously so that awards can truly be made at market prices. If small businesses quote prices matching market prices, then they receive the awards in accordance with the FAR; otherwise these awards, although previously set aside for small businesses, go to large

<sup>8</sup>Unfortunately, no data are available on how often this occurs. DPSC now plans to enhance SPEDE to include on its bidders' list the small business that received the last award for the item in an RFQ as well as large firms.

<sup>9</sup>FAR 13.105. See the two prior footnotes for descriptions of DPSC plans to add large vendors to the SPEDE application.

<sup>10</sup>Of course, DoD buyers can and do refer to price catalogues, procurement histories, and other sources of pricing data, but none of these provides a full picture of up-to-date market prices.

businesses instead. This is an example of how EDI enables the FAR to be implemented more accurately and quickly while requiring a change in the way work is done.<sup>11</sup>

6. POPS serves as an example of a successful EDI application that has not focused on pipeline benefits and thus may not have been designed to maximize such benefits. When POPS was evaluated by the DoD inspector general, various cost savings were estimated (i.e., reduced inventories and handling costs), but no effort was made to determine whether POPS resulted in faster or slower deliveries to end users.<sup>12</sup>

The above list is not meant to imply that DoD users are not seeking innovative uses for EDI. There are in fact several instances in which DoD EDI applications have incorporated changes in the way work is done to exploit electronic transactions, many of which were cited in Section III.

In summary, the potential gains in the target areas described in Section III require changes in the way work is done as well as careful design and implementation of EDI applications. The effects of EDI application on actual logistics outcomes must also be closely monitored to ensure that anticipated benefits are achieved, unexpected costs are minimized, unforeseen opportunities are exploited, and shifts in workload and responsibilities between work units are recognized and accommodated. DoD's use of EDI shows evidence of some of this care in design and implementation, but much more work must be done on existing and planned EDI applications.

#### LINKS ARE WEAK BETWEEN EDI AND INTERNAL SYSTEMS

Closely related to the obstacle above is the fact that most DoD EDI applications are not well integrated into DoD's internal logistics management systems. In addition to lacking interfaces to receive transactions electronically, few of these internal systems, either existing or planned, are designed to take advantage of electronic transac-

<sup>11</sup>We emphasize that we are not proposing that EDI be used to reduce small business participation. This study is concerned with how EDI might be used to meet the FAR's intent for full and open competition among interested and qualified vendors while shortening logistics pipelines. Indirectly, these techniques may reduce DoD's costs if awards are closer to the market prices the FAR identifies as a target.

<sup>12</sup>Office of the Inspector General, 1987.

tion exchange, including the use of electronic agents. The lack of such internal system capabilities impedes the flow of information between EDI transactions and internal systems while hampering managers' efforts to exploit EDI's potential advantages.

Building such interfaces and capabilities may often be technically straightforward but could nonetheless become a challenge when complex systems are involved and when the need for such interfaces has not been anticipated in a system's design (a problem that exists even for some DoD systems still on the drawing boards). As MODELS is implemented using X12 syntax for internal DoD transactions, the interfaces themselves should become somewhat easier to develop.

There are many examples of this problem. NOSC Jacksonville's EASE buyers, for example, must manually edit screens in the Navy's Automation of Procurement and Accounting Data Entry (APADE) system before RFQ information can be electronically transferred to the EASE system. Quotes received from EASE vendors must also be printed out and hand-scanned back into APADE. The SPEDE application is similarly hampered by inadequate interfaces with internal DLA systems. While using SPEDE, for example, buyers can query procurement history only for buys made through SPEDE since its outset, not the more comprehensive procurement history data in DLA's conventional purchasing system.

In MCLB, Albany, transportation planners and consignees can query a regular Navy system to see the status of their requisitions (and pending shipments), but no interface allows them to see shipment status while shipments are in a carrier's hands—data available from the EDI shipment status reports received daily by MCLB, Albany. Furthermore, GBLs must be hand-keyed into a stand-alone personal computer system after transportation planning is complete to produce GBLs in electronic formats. This stand-alone system was developed locally by MCLB, Albany, to eliminate the need to key the GBLs in twice—once to fit on the still-required hard-copy DoD form and once to produce an electronic file of X12-formatted GBLs to transmit to the carrier and other DoD points.

Moreover, no plans yet exist for providing the available EDI shipment status reports to receiving points. MTMC's CONUS freight management (CFM) system, now under development, will provide receiving points with electronic copies of GBLs, but even for these transactions, receiving points will be given limited capability to actually manage their workloads more effectively. GBLs will be used primarily to check shipments as they arrive, to allow discrepancies to

be noted, and to acknowledge receipt so as to speed the invoice and payment process.

In summary, many DoD logistics systems are now being upgraded, and many of these are anticipating in their design the exchange of EDI transactions. But much effort must yet be made to incorporate into these systems' designs the ability not only to receive but actually to fully exploit EDI transactions.<sup>13</sup>

#### **EFFORTS HAVE BEEN HAMPERED BY REGULATORY AND LEGAL QUESTIONS<sup>14</sup>**

Because EDI is a new way of conducting business, its use was not anticipated in current statutes and regulations governing DoD logistics. Hence, there are few rules prohibiting it but even fewer explicitly allowing it. There are few legal precedents, for example, establishing the validity of EDI transactions as authentic events, as contractual commitments, as source records, or as negotiable instruments either within DoD or in the private sector. Nor has any lawsuit addressed these questions despite the fact that EDI has been used for almost two decades.<sup>15</sup> And because EDI is a new application of technology, most EDI applications are scrutinized more closely than are more conventional methods of accomplishing the same ends—a distinction that sometimes leads managers to use EDI more cautiously or narrowly than statutes or regulations dictate.

Together, these factors create an uncertain environment in which innovative logistics managers must figure out how best to use EDI and how to move ahead to full-scale implementation. Not surprisingly, and at least partially because of these factors, many DoD EDI applications do not aggressively tap the technology's potential to en-

<sup>13</sup>In the procurement function, each defense component has one or more contracting systems at some stage of modernization to extend the automation of the internal buying process—e.g., the Air Force's Acquisition Management Information System (AMIS), Base Contracting Automated System (BCAS), Contract Data Management System (CDMS), the Navy's APADE system; the Army's Standard Army Automated Contracting System (SAACONS) and Integrated Procurement System (IPS); and DLA's Standard Automated Materiel Management System-DLA Preaward Contracting System (SAMMS-DPACS). Per Drake, 1989 (pp. 4-4 through 4-6), four of these already incorporate plans for electronic solicitations: BCAS, CDMS, IPS, and SAMMS-DPACS. See Drake, 1989, for a detailed analysis of the status of these and DoD's various other automated procurement systems.

<sup>14</sup>The authors are not attorneys, so the interpretations of laws and regulations in this report should be considered only lay interpretations. Any steps to change laws or regulations should be taken only after consultation with legal counsel.

<sup>15</sup>Wright, 1989, p. xxi.

hance logistics functions. Some also go extra lengths to accommodate vendors by providing free software, training, and ongoing support.

Before DoD's EDI efforts can move forward full stride, several of these uncertainties need to be addressed. The Office of the Secretary of Defense and its EDI Users' Group are helping this effort by coordinating the sharing of EDI application and experience across defense components; by sponsoring the development of EDI implementation guides (as is the GSA); by issuing a directive to use X12 EDI transaction standards or to move toward their use; and even by working to have specific regulations changed. For example, GSA and the Office of the Secretary of Defense (OSD) were instrumental in facilitating the drafting and approval of amendments to the Federal Property Management Regulations to allow the use of EDI to document and pay transportation bills.<sup>16</sup> But more work is needed, especially to answer the following critical questions:

1. What is the status of EDI transactions within DoD regulations and federal procurement statutes? Are EDI transactions acceptable as legal evidentiary records, and are they enforceable? If so, under what conditions?
2. Similarly, what is the status of EDI transactions under general commercial law?
3. Can EDI be considered a prerequisite for doing business with DoD, especially for small businesses?
4. How can DoD's competitive process, as defined by the FAR, use the electronic tools enabled by EDI?

Each question will be discussed below.

#### **Can an EDI Transaction Be a Binding Commitment Under Regulations and Statutes Governing DoD?**

The FAR governs all federal government procurements, interpreting federal procurement law as supplemented by the DFARS (DoD FAR Supplement). It stipulates that contracting officers "sign" contracts, that the officer's identification be "typed, stamped, or printed on the contract," and that contractors must "sign" contracts.<sup>17</sup> There are several other references to a paper-based system: a "public bid

<sup>16</sup>See 41 CFR Part 101-41.002(c) and (d), 41.006, 41.107, and 41.104.

<sup>17</sup>FAR 4.101, 4.102.

opening";<sup>18</sup> making awards "by written notice";<sup>19</sup> and many prescribed forms for submitting contractual information. But is an EDI transaction a "written" notice? And is an electronic identification code or electronic signature a "signature"?

Similar questions arise regarding the use of EDI transactions for evidentiary records of business transactions. Traditionally, such records have been stored on paper. For private businesses, courts and administrative agencies generally accept computerized records as evidence if such records are reliable and credible.<sup>20</sup> This means that techniques must be employed to ensure the reliability and credibility of EDI records, such as audit trails and archiving on unerasable media.

Federal law does permit electronic records if they are maintained under certain reasonable conditions to ensure accuracy, authenticity, and completeness. The GSA and the National Archives and Records Administration (NARA) have just amended their regulations to clarify when electronic record keeping is permissible.<sup>21</sup> DoD laws and regulations do not prohibit contractors or DoD from using electronic records to document contract actions, but they do not explicitly permit them.

Clarifications for the use of EDI are needed, but there are precedents for such changes and opportunities to vary procurement rules by size of buy. The FAR has already been modified as technology has changed *and* has less stringent requirements for small purchases. For example, contractors' signatures received by facsimile are permissible for small purchases,<sup>22</sup> as are unsigned, "written, telecommunicated" purchase orders under certain conditions.<sup>23</sup> Not specified, however, is whether "*written, telecommunicated*" orders include EDI transactions. Moreover, it would appear that such an unsigned purchase order can be cancelled only by a written notice accepted in writing by the contractor.<sup>24</sup> The FAR also permits approved automated formats or teletype to be used for written solicitations in lieu of a standard paper form.<sup>25</sup> It also stipulates that quotes should gener-

<sup>18</sup>FAR 7.306.

<sup>19</sup>FAR 14.407-1.

<sup>20</sup>Wright, 1989, p. 13. See also pp. 63-65.

<sup>21</sup>*Federal Register*, May 8, 1990, p. 19216, showing amendments to 36 CFR Part 1234 (NARA regulations) and 41 CFR Part 201-45 (GSA regulations).

<sup>22</sup>FAR 13.501(g).

<sup>23</sup>FAR 13.506.

<sup>24</sup>FAR 13.504(b).

<sup>25</sup>FAR 13.107(4) and (6).

ally be solicited *orally* for small purchases,<sup>26</sup> presumably to simplify and speed the procurement process. Oral quotes are usually solicited by phone—an error-prone and often inefficient process.

EDI can be implemented to meet the *intent* of the FAR and, if done with care, can provide more control and accuracy than current techniques already permit, at least for small purchases. In short, to enable DoD managers to use EDI more aggressively, the FAR must be revised to make EDI *explicitly* permissible and must clearly define the conditions for its use.<sup>27</sup> For larger buys, the FAR will need more scrutiny and revision, but not until security provisions are tested and validated to provide assurance of authentication and accuracy intended by the FAR for such transactions. The DFARS will need to be similarly revised to be consistent with the FAR.

#### **What Is the Legal Status of EDI Transactions Under Commercial Law?<sup>28</sup>**

The legal status of EDI under laws and regulations governing commerce by public and private enterprises poses additional questions that need resolution. A variety of laws are involved, including the Uniform Commercial Code (including Article 2, Section 2-201, of the Statute of Frauds), the Federal "Statute of Frauds" (31 U.S.C. 1501), the Fair Labor Standards Act (FLSA), the Controlled Substances Act, Internal Revenue Service rulings, and several other laws dealing with business transactions.<sup>29</sup>

These and other laws need revisions so that EDI is explicitly recognized and its legal status clarified. Changes will be necessary to recognize and specify conditions under which EDI transactions will be considered legally binding commitments, authentic, evidentiary records, and negotiable documents, as well as to specify how proof of delivery will be made. Fortunately, the Office of Federal Procurement Policy (OFPP), the American Bar Association (ABA), the Electronic Data Interchange Association (EDIA), DoD, and others are working to define what laws need to be changed and how. In 1987, the International Chamber of Commerce adopted Uniform Rules of Conduct for Interchange of Trade Data by Teletransmission (UNCID)

<sup>26</sup>FAR 13.1006(3).

<sup>27</sup>See Drake, 1989, Appendix B, for sample wording changes to the FAR and DFARS.

<sup>28</sup>See Wright, 1989, for a more detailed discussion of legal issues raised by EDI.

<sup>29</sup>Ibid., pp. 1-16, 87.

to help clarify the legal status of EDI, but UNCID is still too new to have had a substantial effect, and its legal status in the United States remains unclear.<sup>30</sup>

As with the FAR, U.S. business laws and the Federal "Statute of Frauds" assume paper-based business transactions, referring to "written" and "signed" documents and paper records.<sup>31</sup> Some of these regulations have been changed to acknowledge the use of older technologies such as telegraph and telex, but EDI has not yet been addressed. Moreover, there are few if any good models of existing EDI applications with all of the proper features that revised laws would presumably require—e.g., reliability, auditability—and no one model, even when developed, will be appropriate for the myriad types of EDI transactions between DoD and private companies. EDI applications and networks can be designed to *increase* reliability and to control and *reduce* legal problems, not the converse.

These legal uncertainties need not slow DoD's progress toward electronic commerce. While pursuing needed legal changes, DoD can rely on carefully constructed trading partner and network agreements, drawing on various examples and guidelines to progress with its plans for electronic commerce.<sup>32</sup>

### **Can EDI Be Considered a Prerequisite for Doing Business with DoD, Especially for Small Businesses?**

A significant obstacle to the use of EDI within DoD appears to be uncertainty about the effects of electronic commerce on small businesses.<sup>33</sup>

<sup>30</sup>Ibid., p. 2.

<sup>31</sup>See Weiss, 1990. OFPP has drafted changes to the "Federal Statute of Frauds" (31 USC 1501) to enable electronic contracts.

<sup>32</sup>See Wright, 1989, pp. 17–54, for a detailed discussion of trading partner and network agreements. Appendix A of Drake, 1990, also provides a sample trading partner agreement for DoD.

<sup>33</sup>Questions of barriers to entry introduced by EDI are also raised for large businesses. For example, use of EDI in transportation for a variety of transactions is facilitated by guaranteed freight agreements to limit the number of carriers with which DoD must interface. (This may be unnecessary as more firms are linked electronically.) When DoD implemented its surface transportation EDI pilot project, EDI capabilities were a necessary prerequisite to receiving a guaranteed freight agreement under the project. This prerequisite has continued as the project has been extended. But a similar project for ocean carriers was stalled because of the reluctance of contracting officers to set EDI capabilities as a prerequisite. This was considered an excess burden for carriers despite the expressed interest of a group of carriers in participating in the pilot project.

It is important that DoD's approach to electronic commerce not introduce a barrier to qualified small businesses for at least two reasons:

1. By law, DoD is required to procure goods and services using full and open competition among all responsible sources, including small and disadvantaged businesses. In FY88, 9 million DoD procurement actions were with small businesses, totaling some \$25 billion, or 69 percent of all such DoD actions for work in the United States.<sup>34</sup>
2. For responsiveness during surges in demand especially, DoD needs broad access to as much of the U.S. industrial base as possible, including small businesses.

How does DoD's use of EDI affect small businesses? The answer to this question will depend on *how* DoD implements EDI in specific applications and how its overall EDI infrastructure is designed. EDI can be used in many ways to actually *reduce* barriers to small firms conducting business with DoD. For example, EDI applications can be designed to "level the playing field" between large and small firms by making information on buys as close as a modem and a personal computer; to reduce redundant document submissions; to enable firms to be paid faster; and to standardize transaction formats across the hundreds of DoD buying points. In such ways, EDI can reduce the effort needed to do business with DoD for large and small firms alike. These capabilities may have a more positive effect for small businesses, for such companies may have had fewer resources than larger firms to overcome these costs of doing business with DoD in a paper-based environment—costs that may now be prohibitive for some firms.

In contrast, if DoD were to implement EDI to make only transactions and reporting on very large contracts easier, or in such a way that DoD vendors would themselves gain little or nothing from electronic commerce and have to invest in specialized equipment and software, the effects could be detrimental to small businesses.

<sup>34</sup>These transactions accounted for 19 percent of the dollar value of procurement amounts. This excludes 1.1 million transactions from work outside the United States with foreign or domestic firms and another 1.1 million with foreign governments, U.S. government entities, or education and nonprofit institutions. Department of Defense Summary of Procurement Awards (Format Summary), October 1987 to September 1988, Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, Washington, D.C.

There is little systematic empirical evidence to date on the actual effects on small businesses of DoD's use of EDI or whether EDI poses a barrier—i.e., an unreasonable obstacle—to small businesses working with DoD. We do not know, for example, how many small businesses now use EDI; nor do we know how many have the requisite software. We do, however, know several things that shed light on the issue.

Small and large businesses already face obstacles to doing business with DoD—obstacles for which various DoD- and SBA-operated mechanisms attempt to compensate. These firms sometimes have trouble finding out what DoD wants to buy; must use forms that differ across DoD's hundreds of buying points; must follow prescribed steps precisely in order to get paid; and must sometimes wait months to receive payment. For these and other reasons, some surmise that many firms, both small and large, decline to do business with DoD already.<sup>35</sup>

In 1989, the comptroller general ruled that an Army Corps of Engineers' solicitation requiring that cost proposals be submitted on computer disk was not unduly restrictive because submitting information in this way reduced time and errors in proposal evaluations and complying with the requirement was relatively inexpensive. (The Army provided preformatted and programmed diskettes to offerors.<sup>36</sup>) Hence an electronic transfer of data—albeit on diskettes—was judged not to be an undue barrier because of the way it was implemented and the significant gains it afforded the Army. Roughly half of small businesses already have the basic hardware to send and receive EDI transactions.<sup>37</sup>

In late 1989, we conducted a survey of the 42 vendors selling medical products to the DPSC for overseas medical facilities using DPSC's version of SPEDE. Seventy-eight percent of the vendors responded and all but one was a small business. Half of the respondents already had PCs before SPEDE went on line, and half already had modems. Those implementing EASE anecdotally reported that when they introduced EASE at meetings with vendors, well over half of the vendors indicated that they had the requisite equipment.

<sup>35</sup>See, for example, Under Secretary of Defense (Acquisition), 1988, p. 36.

<sup>36</sup>Comptroller General Decision B-234490, May 26, 1989.

<sup>37</sup>*The State of Small Business*, 1988, shows computer use by firm size (1985 statistics). These data indicate that 54 percent of firms with 10 to 19 employees use computers, as opposed to 73 percent with 20 to 49 employees and 82 percent with 50 to 99 employees. These figures have probably risen significantly during the succeeding five years with the growing availability of inexpensive yet powerful personal computers.

For those vendors without these capabilities, the minimum hardware and software buy-in cost is roughly \$3,500 for a microcomputer, a modem, a printer, and software. Ongoing costs to use EDI will vary widely depending on how DoD's electronic infrastructure for EDI is designed. If DoD were to provide free electronic mailboxes for interested vendors on a DoD wide-area network (WAN), ongoing vendor costs for telecommunications might be that of local phone calls. If DoD does not provide such mailboxes or if a vendor chooses not to use one, the vendor could use a mailbox on a commercial WAN. Costs for this arrangement would vary according to the WAN's charging structure and any discounts negotiated by DoD or vendor groups. For example, NSC Jacksonville has negotiated a flat rate of \$50 per month for EASE users to use CompuServe's commercial WAN. Hence, \$50 a month is a reasonable low-end estimate for a vendor using a commercial WAN. A high-end estimate could vary by level of usage. Each transaction might cost roughly 82 cents, including a minimum monthly charge of \$25 for an electronic mailbox.

Are such costs above or below current transaction processing costs for businesses, large or small? We do not know. Postage alone for sending transactions via mail is likely cheaper than via EDI. But several SPEDE vendor respondents commented that using SPEDE to conduct business was more efficient and faster. Presumably, this translates into net cost savings. (No vendors DPSC asked to become SPEDE vendors at the outset of the prototype refused to do so.) In fact, when asked how much they would be willing to pay monthly if a SPEDE-like system gave them access to more DoD buys, 45 percent of vendors reported that they would pay \$50 or more.

Several of DoD's first EDI applications involve small businesses. Of 30 vendors involved in DCSC's POPS, 16 are small businesses, and 97 percent of SPEDE vendor respondents identified themselves as small businesses. Some private firms report that small businesses are better suppliers to have in direct-stock delivery arrangements such as those needed for just-in-time inventory management because a larger share of the small firm's business is directed to supporting one large firm. DoD may find the same, making the shift toward more indefinite delivery contracts facilitated by EDI (as used by POPS) less of a threat to small businesses than it first might appear.

Despite projections for widespread use by the mid-1990s, most firms in the United States do not yet use EDI. We do not know how

many small businesses use it, but in a recent survey across all firms, only 17 percent reported using EDI even to a limited extent.<sup>38</sup>

In summary, given its cost to vendors, EDI would not appear to pose a significant cost barrier to doing business with DoD for most firms even today. In fact, many firms may find that they receive net benefits from EDI in terms of lower transaction costs and *reduced* barriers.

There are several steps that DoD might take to use EDI to reduce negative effects on small businesses. DoD is already pursuing some of these.

First, DoD can work with SBA, industry groups, and other interested organizations to determine whether EDI now poses a significant barrier to small businesses and, if so, to what extent, in what ways, and for what industries or types of businesses.

Second, DoD could work with these organizations to demonstrate to small businesses alternative ways to use EDI and how to gain net benefits from its use. OSD is already pursuing this course by exploring with private sector volunteers ways DoD's Intelligent Gateway could facilitate small-business use of EDI.

Third, DoD's software, hardware, and telecommunications infrastructure can be designed to facilitate the use of EDI by small businesses. As DoD is now planning to do, this infrastructure should incorporate, to the extent possible, transaction and communications standards used by industry.

Fourth, this infrastructure for EDI should accommodate multiple telecommunications routes to DoD's "electronic door" for vendors, depending on their preferences. For example, some firms may want to exchange transactions with DoD via electronic mailboxes on various commercial WANs. Others may not be able to receive transactions in electronic form, but only via facsimile machine or even conventional mail.

#### **How Can DoD's Competitive Process as Defined by the FAR Take Advantage of the Electronic Tools Enabled by EDI?**

DoD's mandate to compete most of its buys fully and openly can be facilitated by EDI-enabled tools. Bulletin boards, electronic brokers, broadcast systems, and cross-vendor databases can help DoD reach thousands of vendors known and unknown to DoD, potentially

<sup>38</sup>See Masson and Hill, 1989.

speeding procurements, increasing access to the industrial base, and helping to meet unexpected surges in demand.<sup>39</sup> But how can DoD take advantage of such tools given that its suppliers must often comply with Walsh-Healey Act provisions and often be identifiable as small businesses as defined by the FAR?<sup>40</sup> Second, how can potential reductions in PALT be achieved given the FAR's minimum time requirements for presolicitation and solicitation steps for many competed purchases?<sup>41</sup> These two areas of concern are discussed in turn below.

Almost all DoD buys over \$10,000 are governed by the Walsh-Healey Act. This act requires that DoD do business only with firms that are manufacturers or regular dealers in the supplies manufactured or used in performing the contract.<sup>42</sup> A regular dealer is one that regularly maintains a stock of the item to be purchased on a "continuing and not on a demand basis."<sup>43</sup> Manufacturers or dealers are permitted to bid, negotiate, and contract through an authorized agent if that agent acts and contracts in their name.<sup>44</sup> The act's legislative history and subsequent case law make clear that the act was intended, among other things, to eliminate the award of contracts through "bid brokers" so as to "restrict bounty for government contracts" and to provide labor-standard protection to employees who actually manufacture or provide services to the federal government.<sup>45</sup>

In addition to these Walsh-Healey Act restrictions, almost all DoD buys not exceeding \$25,000 are to be set aside for competition among small businesses, as defined by the SBA.<sup>46</sup>

Hence, any EDI-enabled tool used by DoD must allow any vendor interested in conducting business with DoD to identify itself (or be so identified by DoD as in a cross-vendor database) as eligible under the Walsh-Healey Act and, in many cases, as a small business. This

<sup>39</sup>Such tools might also lead to reduced prices paid by DoD.

<sup>40</sup>There are other restrictions on the types of businesses that DoD can do business with in particular situations, such as small business-labor surplus set-asides and small disadvantaged business programs. These affect a far smaller share of DoD business and are thus not discussed here explicitly. Generally, the suggestions made in this subsection can apply to them as well. As discussed in Section III, when vendors need special qualifications or their items need on-site inspections before acceptance, EDI will be less useful in the target areas affecting procurement.

<sup>41</sup>FAR 5.002, 5.1, 5.2.

<sup>42</sup>FAR 22.6.

<sup>43</sup>FAR 22.606-2(1).

<sup>44</sup>FAR 22.607.

<sup>45</sup>41 CFR 50.206.50 and *Stuart Petroleum Co. v. U.S.*, D.C. 1971, 438 F. Supp. 527.

<sup>46</sup>FAR 19.1. FAR 19.102 actually lists the size restrictions by Standard Industrial Class (SIC) code in terms of annual receipts or number of employees.

could fairly easily be built into such tools at the outset if DoD can influence their design. If this is not done, DoD's use of such tools even in such critical areas as spare parts could be severely restricted if not prohibited. For example, two electronic cross-vendor aviation parts databases now in use do not incorporate such features, so DoD users must first contact vendors of interest by phone to establish their eligibility rather than electronically as supported by the databases. We recommend that DoD begin working with users and owners of tools of special interest to DoD to ensure that such features are built in.<sup>47</sup>

Even with these actions, however, the Walsh-Healey Act may need to be reviewed and revised (or reinterpreted by the secretary of labor) in order to maintain its intent while not unnecessarily restricting DoD's use of EDI tools for electronic commerce. For example, EDI enables firms to minimize or even eliminate their inventories by using just-in-time inventory management. For some commodities, firms can manufacture or, if they are dealers, acquire items on demand, matching stock to demand even on an hourly basis. Under the Walsh-Healey Act, however, such innovative, well-managed firms would in most cases be ineligible because they would not have "regular stocks." The act already excludes several commodity groups from the stock requirement where dealers have moved away from maintaining physical inventories. For example, perishables and agricultural products are statutorily exempt, and coal dealers and periodical agents have regulatory exemptions. More such exemptions will likely be required as more commodity groups are handled by dealers or agents using EDI and other techniques to reduce or eliminate inventories.

The act permits DoD to deal with agents, not brokers, but EDI-enabled tools will blur the line between these two. For example, if a cross-vendor database using EDI is designed to speed up the match of buyers and sellers, it could be considered an agent. Once a DoD buyer found a few interested sellers on a database, the buyer could exchange EDI transactions directly. With EDI, however, this non-DoD electronic service could be extended to employ an electronic "agent" (as defined in Section I) to automatically screen or even eliminate and accept sellers' offers on the basis of DoD-defined parameters (e.g., small-business eligibility, price, or availability).

<sup>47</sup>The EASE bulletin board system for small purchases has addressed these eligibility questions with a simple registration process. Any vendor can browse the system, but vendors wishing to submit quotes must first send in a form certifying their eligibility, after which they receive passwords enabling them to submit quotes.

If this service were provided as part of a non-DoD EDI service, it would appear to violate the Walsh-Healey Act. If the same capability were performed on the transactions once such transactions crossed the DoD threshold, it would be permissible. In such cases, the Walsh-Healey Act may unnecessarily restrict DoD's options to fully exploit innovative, non-DoD electronic tools. The use and required features of EDI-enabled tools such as bulletin boards, brokers, and cross-vendor databases must be clarified in light of DoD's regulatory and statutory procurement requirements. Finally, as mentioned in Section III, FAR requirements dictate the minimum length of PALT in some cases.<sup>48</sup> If the CBD is put in electronic form as suggested in Section III and proves to be much more quickly (and usefully) accessible to relevant vendors,<sup>49</sup> then the FAR's intent can be met within much shorter time limits. Today's mandatory restrictions on the length of PALT will need to be revised such that it does not unnecessarily limit gains made possible through the use of electronic procurement tools.

#### **STANDARDS AND NETWORK APPROACHES ARE INCOMPLETE AND REFLECT PAPER METHODS**

DoD has mandated the use of the ANSI X12 standard for EDI transactions and has begun developing implementation guides on how to use such standards consistently across DoD buying points. These guides are critical because many fields in X12 transactions, and even the transactions themselves, can be used in different ways. For example, one buyer might use a purchase order (X12 transaction 850) to order an item from a supplier, while another might use a release order against a larger contract to order the same item from the same supplier. A third buyer might use a purchase order (850) followed by individual releases (830). All are legitimate uses of transactions—but in combination, they put the supplier in hardly a better position than if each buyer used a proprietary system.

Also, plans and prototypes are now under way to create the software and network infrastructure that is needed for DoD's widespread use of electronic commerce. Despite this progress, the standards,

<sup>48</sup>FAR, Part 5.201(c). Smaller DoD solicitations, over \$10,000 but not exceeding \$25,000, must be posted in a public place for at least 10 days but can be awarded within that time (FAR 5.101 [a] [2]), so this does not explicitly set a minimum length on PALT. The FAR's intent, though, encourages wide public dissemination of these small solicitations as well.

<sup>49</sup>The question of what is accessible enough is addressed in Section V.

guidelines for their use, and network infrastructure are incomplete. Consequently, current DoD EDI efforts are hampered because they have to solve problems in these areas and often do so idiosyncratically with solutions that will not be applicable across DoD. EDI transaction formats will take years to mature and become adopted as a cross-industry business standard. Even though ANSI X12 has been mandated by DoD and, within the United States, appears to be the most widely used standard, EDIFACT, following a different standard process and syntax, is attracting users and attention. The manner in which EDI standards evolve internationally could significantly affect DoD because of U.S. defense commitments worldwide, its use of foreign suppliers, and, most important, the involvement of DoD's U.S. suppliers in international markets. Some U.S. firms with worldwide markets are already calling for one EDI standard in the future—and not necessarily X12 or EDIFACT.

Even within the United States, many EDI users do not yet use X12 formats. In 1989, roughly one-third of U.S. firms using EDI reported that they used proprietary standards, with the remainder using X12, industry standards, or EDIFACT.<sup>50</sup> Similarly, although over half of SPEDE vendors reported exchanging electronic transactions with non-DoD suppliers or customers, only 12 percent of these reported using X12, and several had never heard of this format. Entire electronic marketplaces have been built on proprietary standards that have become de facto industry standards.

But there is movement toward X12. Industries such as freight transportation, retail groceries, and health care are moving existing industry and proprietary standards toward X12.<sup>51</sup> DoD now needs to enhance its participation in the standards development process to encourage transaction standards that take full advantage of the electronic format, eliminate redundancies, and facilitate interactive EDI when beneficial.

Another X12 transaction format challenge lies in the design of electronic formats for use of the electronic tools described above—e.g., formats for queries of databases to determine stock availability and price; for RFQs; for transmitting repair priorities and receiving status reports on repairs; and for bid submittals.<sup>52</sup>

<sup>50</sup>TDCC, 1989, p. 15.

<sup>51</sup>For example, EDIA, formerly the Transportation Data Coordinating Committee (TDCC), is working with ANSI committees to move TDCC standards into the ANSI X12 arena. Baxter Healthcare, a major EDI player in health-care supplies, is revising its proprietary electronic supply system to comply with ANSI X12.

<sup>52</sup>Some of these formats are in development.

DoD's active, substantive involvement in the development of common EDI transaction formats for adoption by U.S. commerce is critical to ensuring that such standards accommodate DoD's unique requirements, are widely accepted by both current and potential DoD vendors, and fully exploit their electronic form.

## V. NETWORKS AND SOFTWARE FOR EDI

This report has presented options, opportunities, and priorities for the use of EDI in handling business transactions between DoD and companies within the private sector. This section addresses networking and software issues that DoD is likely to encounter in moving to electronic commerce and then presents a set of recommendations for overcoming existing technical obstacles.

The vast majority of DoD EDI transactions will be sent over telecommunication networks and will be aided by software programs at various stages both within the network and within the source and destination computers.<sup>1</sup> Given all the alternatives within both DoD and the commercial sector for structuring and interconnecting these networks, what are the factors and options a DoD agency must consider in establishing an EDI link to suppliers and contractors, both now and in the foreseeable future? In particular, we seek effective ways to use networks and software in addressing the key target areas described in Section III of this report. Toward this end, the objectives of DoD network and software support for EDI should be to:

1. Provide a common, easily accessible method of EDI information exchange between DoD and its suppliers and contractors across all DoD components, building to the greatest extent possible on EDI software and network standards currently being developed in the private sector;
2. Provide an environment in which the electronic tools mentioned earlier can operate effectively—e.g., broker systems, bulletin boards or broadcast systems, cross-vendor databases, and agent programs; and
3. Ensure the privacy and security of EDI data as required by law or by operational policy and regulations.

Strategies for achieving each of these objectives are addressed below.

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<sup>1</sup>We say "vast majority" rather than "all" because under some specialized circumstances it may be more efficient or effective to transmit a batch of EDI transactions physically via a magnetic tape or an equivalent medium.

## PROVIDE A COMMON, EASILY ACCESSIBLE METHOD FOR EDI BETWEEN DoD AND ITS SUPPLIERS

In any consideration of the network and software environment required for effective DoD use of EDI—involving as it does interrelationships among local-area networks<sup>2</sup> (LANs), WANs,<sup>3</sup> and gateways<sup>4</sup> between networks—it is useful to have in mind an overview of a generic network architecture linking a DoD agency with an external supplier or contractor. As shown in Figure 5.1, individual DoD agencies may or may not have internal local area networks but will be tied into a private DoD wide-area network, such as FTS2000 or the Defense Communications Agency's AUTODIN, AUTOVON, or Defense Data Network (DDN). In turn, there may be gateways linking the private defense network or networks to commercially available WANs such as CompuServe, Telenet, and many others so that data may be widely accessible to firms that lack easy access to the DoD WAN.

To achieve the goal of a common method of interchangeability of EDI transactions between DoD and its suppliers, we must address three primary subgoals: (1) use of a common data format for EDI information, which involves translation of internal DoD formats to and from EDI standards; (2) the definition of the network architecture to be used to provide public access to DoD data, and by which DoD accesses EDI data from commercial sector companies; and (3) assurance of adequate capacity for data volumes and traffic—that is to say, assurance that the expected volume of data traffic generated by use of EDI will not be burdensome or harmful to the operation of existing and planned data networks. The following subsections describe approaches to achieving each of these subgoals. Costs to DoD of suggested approaches are also estimated.

<sup>2</sup>A *local-area network* provides a communication path, usually high speed (over several million bits per second), between computers within a building or other close geographical area not exceeding a diameter of several kilometers. For these and other telecommunication terms and concepts, see Tanenbaum (1988).

<sup>3</sup>A *wide-area network* typically spans entire states or countries and has been lower speed (although that restriction will change with the wide availability of fiberoptic links and fiber-oriented switching systems). A WAN often uses common-carrier networks for a portion of its functionality.

<sup>4</sup>A *gateway* is a network node providing a connection between two networks, usually with dissimilar protocols.

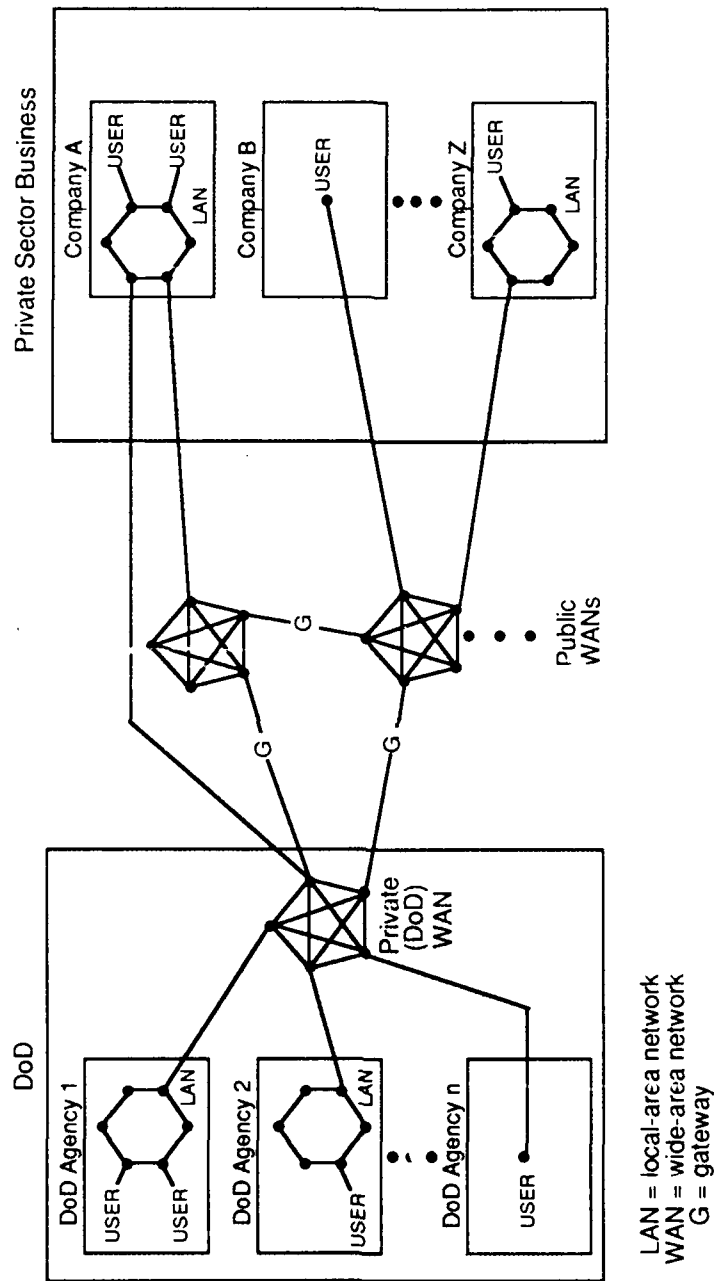


Fig. 5.1—Network architecture for DoD EDI

### **Use of Common EDI Formats and Translation to and from DoD Internal Data Formats**

As discussed in Section IV, DoD has mandated the use of the ANSI X12 standard for EDI transactions with the private sector. This standard provides the "target" common data format for these transactions to and from which internal DoD formats must be translated. Hence, within the limits discussed in Section IV, a common EDI data format for EDI transactions is well along. This is important not only for DoD's internal purposes but also for the ability of that format to ease the effort of vendors to do business electronically with DoD.

These X12 formatted transactions must, however, be translated to and from DoD's and vendors' internal formats. Defense components have been using common electronic formats for internal transactions for many years. As a result, much of the routine data required for typical EDI transactions—such as generating purchase orders, requests for quotations, and similar transactions—are already in machine-readable form within DoD databases. The formats for these common transactions are now being updated in the MODELS program.

The MODELS format is based on the ANSI X12 EDI syntax, although the labels and contents of some fields in some transactions vary owing to unique DoD requirements and to the fact that MODELS covers only internal transactions, not transactions with external organizations. As a result of these forward-looking programs, most routine transactions can be readily converted back and forth between MODELS and "pure" X12 EDI formats via commercial translation packages.<sup>5</sup> A number of these programs operate on popular personal computers. Important considerations regarding PCs and "gateway" nodes in EDI networks are discussed in a separate subsection.

If DoD-specific information lacking a current X12 field must be transmitted, that information can be placed into X12-optional or remarks fields during translation from DoD-specific to X12 format but can retain its formatted nature so that receiving programs might automatically interpret the data if they have been designed to check for its existence. If non-X12 auxiliary information must accompany DoD-related EDI transactions, private enterprise should develop tailored X12 interpretation programs to process the DoD-specific information

<sup>5</sup>Such packages exist for almost all types of computer hardware, but not for all hardware currently used by DoD for logistics information systems (Drake, 1990, pp. 4–25).

on widely used computers. The result for the time being, however, would be an informal DoD extension to the standard X12 formats. The Office of Federal Procurement Policy is considering whether to recommend that X12 develop a "Government Representations and Certifications" (GRC) transaction set modeled after the "Trading Partner Profile" transaction set to facilitate transmission of government-specific procurement information. If this happens, DoD and other government-specific requirements would be brought into formal X12 transaction formats.

Software programs performing X12 translation, however, are not sufficient to the task of enabling DoD and private vendors to exchange commonly understood EDI transactions. As discussed in Section IV, translation guidelines are also needed along with conventions for the use of transaction formats. Industry trade groups have begun to develop such guidelines for their own needs, and some translation software packages embody these interpretations. DoD's choice of appropriate industry guidelines for its transactions, which cross many industry boundaries, may be problematic. DoD (and the federal government as well) is now tackling this problem by developing its first X12 implementation guides. Once a particular translation approach is chosen, a number of value-added public networks can provide this translation as a service to obtain a company's business in transmitting and storing EDI transactions.

In summary, the process of translating to and from standard X12 EDI formats, both for DoD and for other organizations, presents no serious obstacle to the use of EDI. As discussed in Section IV, however, there is considerable latitude for the interpretation of standard X12 data fields. Individual industry groups are developing industry standards for these interpretations, but DoD procurement crosses many industry boundaries. As a result, DoD must determine which industry interpretations should be used in which contexts.

### **Gateways and Personal Computers**

The use of personal computers or workstations as an intermediary for the translation of both DoD and vendor transactions offers a number of advantages. First, interposing a PC between a communication line and an organization's main computers allows translation to and from internal data formats to be handled without any modification to the main processing computers' programs. Second, security is enhanced by the use of the PC as a specialized gateway to handle all ex-

ternal communications in place of allowing direct communication access to main computers. Third, the PC may process EDI transactions (such as scanning for RFQs relevant to the company's products, emitting invoices, and printing out transactions of interest for human review) to a sufficient extent that no other computation is required to allow small companies to participate fully in the EDI "community."

A major network-related DoD EDI initiative is currently under way at Lawrence Livermore National Laboratory (LLNL), which has been designated the lead agency for engineering research and advanced development of DoD's Electronic Commerce/EDI Project. LLNL's project keystone is its Intelligent Gateway Processor (IGP), which would provide gateway nodes both within the private DoD WAN and for connecting to external networks. At these gateways, one of the services to be provided will be translation between widely used data formats (e.g., MODELS and X12) incorporating, where available, commercial translation packages. The IGP itself is designed to make transparent to the user the numerous and varied network connections necessary to conduct electronic commerce throughout DoD and the business community.

Private companies have also found the gateway concept of value in controlling their electronic message traffic. For example, Texas Instruments (TI) has developed a gateway node through which all external EDI and electronic mail passes to and from the company. The gateway performs translations (e.g., handling Transportation Data Coordinating Committee [TDCC], X12, and EDIFACT standards) and can use the X.400<sup>6</sup> electronic message format standard. It also performs routing of messages internally within TI and has sophisticated error recovery procedures. Such an electronic "single point of entry" has useful security and privacy implications and makes it easy for electronic trading partners to deal with TI.

#### **Network Architecture: Providing Vendors Access to DoD EDI Data**

Given that EDI data format translation can be handled, how should various network facilities available to DoD be used to exchange information between DoD and commercial suppliers and con-

<sup>6</sup>X.400 is a Consultative Committee for International Telegraph and Telephone (CCITT) standard for electronic mail interchange. The standard provides a message header "envelope" to allow routing of electronic messages among users of various electronic mail systems.

tractors? Any network architecture must be easily accessible by both large and small companies—not only the 300,000 or so firms that have expressed interest in doing business with DoD, but also potential DoD vendors that can be alerted to relevant business, identify themselves to DoD, and be qualified as vendors. In this subsection, we deal with the network architecture that will be used to facilitate the transaction of business with known vendors. Network architecture options for electronically reaching the pool of *potential* vendors are discussed under the next objective.

Various options can be exercised to effect data exchange between DoD and its suppliers and contractors. These include:

- *Physically transmitting a data medium*, such as a magnetic tape or a diskette. Pure X12 transactions can be written in a batch on such a medium in a standard format, requiring no other transmission protocol.
- *Using a hard-wired data link* such as a copper or fiberoptic link between two ports on two different computers. In this case as well, pure X12 transactions can be transmitted, since no addressing information is required.
- *Using point-to-point dial-up* (e.g., using a modem on one computer to dial a modem on another), thereby establishing a link that remains dedicated to the session as long as it is in operation. Once the link is established, it may be used as one would a hard-wired link (above), or it may be employed more generally to transmit "messages." An important electronic mail standard for transmitting those messages is the X.400 protocol, by means of which an "envelope" can be created with addressing information surrounding one or more X12 transactions. Current implementations of X.400 messages carrying EDI contents do not identify them as such, but a possible solution now being explored within standards committees involves the creation of a special X.400 message type called P.EDI to retain the EDI identification within the message header. This is a valuable facility because it allows the routing of EDI messages without the need to examine the contents of messages. Point-to-point dial-up is currently used in the SPEDE and POPS EDI testbeds described in earlier sections.
- *Using an electronic mail approach* that employs computer files at various network nodes as electronic "mailboxes" for each possible recipient or group of recipients. A complete transaction would consist of two separate sessions: one for

the sender to post the message in the recipient's box, and another for the recipient to retrieve that message. As in the previous case, the messages would use an X.400 or similar standard header carrying one or more X12 transactions within the message body.

Given the network objectives, the preferable mode of EDI transaction handling lies in the use of electronic mail except in specialized circumstances—e.g., in regular high-volume, longstanding transactional relationships between a DoD agency and a supplier or contractor or for specific security reasons. The main advantages of electronic mail are that:

1. Network resources (and their costs and bandwidth) may be shared among many parties.
2. Both parties to the transaction (actually, their computers) need not be available simultaneously, and their transmission rates need not adjust to the lower of the two parties' maximum baud rates.
3. EDI transactions aimed at a broad, and perhaps unknown, audience, such as general requests for proposals (RFPs) and RFQs, might be sent to one of the number of value-added wide-area networks (VANs) for posting on "electronic bulletin boards" within these nets.

A disadvantage of this mailbox approach is that transactions residing for some period of time in electronic mailboxes will need to be adequately secured. The volumes of transaction traffic between mailboxes might be more easily discerned by third parties than, for example, if protected, dedicated lines were used. These important security issues are addressed in detail below.

If the mailbox approach is used as we suggest, mailboxes will be needed for DoD transaction points (e.g., for buyers and for shipping-and-receiving points) as well as for vendors expressing interest in doing business with DoD. Where should these mailboxes reside? Turning back to Figure 5.1, they could reside on a private DoD WAN or various public WANs. DoD's would most likely reside on a DoD WAN with electronic links via the IGP to various public WANs. This would offer DoD more security and control over its mailboxes and might perhaps be less costly as well (although cost will depend on negotiations with public WANs).

Some vendors may already have electronic mailboxes on public WANs. For vendors without such mailboxes or who prefer to segregate their DoD electronic mail, DoD could provide mailboxes on a private DoD WAN.

The likely choice for the primary DoD WAN would be DDN except that the low-level communication protocol on which DDN is based is Transmission Control Protocol/Internet Protocol (TCP/IP), and the X.400 electronic mail standard does not currently operate under TCP/IP and is not expected to do so for at least five years. DoD must therefore rely on internal mail handling, addressing, and routing standards for use on its private networks. This, in turn, creates a problem in migrating EDI messages from the private network into public networks for which X.400 will increasingly be the electronic mail standard. (Other private DoD WANs, such as AUTODIN or FTS2000, might not have this problem and might thus allow some use of X.400 sooner.)

If the electronic mail network approach is used, one important requirement will be an electronic directory of the electronic addresses of all valid recipients of messages. The lack of such a directory is already hampering DoD EDI applications; vendors making direct deliveries to DoD sites are currently having difficulty finding the electronic addresses of receiving points for required documentation. Both an electronic "white page" directory and a corresponding "yellow page" directory are needed to access specific firms and to locate firms by various attributes. CCITT X.500 provides a standard for the construction of such a directory, but the availability of such directories is limited.

Various industry efforts are under way to speed the creation of such directories, so this important prerequisite may be in place in the near future. For example, the Automotive Industry Action Group (AIAG), concerned about such a shortcoming, is now working with Dun & Bradstreet on a "trading partner profile" that will add an electronic mail address to the basic D&B profile of firms. Within the DLA, the MODELS program is already tied to the Defense Automated Addressing System (DAAS), which provides some of the needed locator/addressing services for DoD locations; DAAS now has 60,000 to 80,000 DoD addresses online. Similarly, DoD has a schema of Contractor and Government Entity (CAGE) codes that could be linked to an electronic address directory or even be merged with one. DAAS and the CAGE code system could well form the basis of an initial DoD EDI electronic directory. Neither of these directories, however, is in X.500 format. Eventual conversion to that standard would help pri-

vate sector companies locate DoD agencies, help such firms address EDI transactions to these agencies, and help DoD locate relevant private sector suppliers. Alternatively, DoD could adopt a schema of unique identifiers for trading partners developed by the private sector, eliminating a separate DoD schema.

The point-to-point dial-up method of EDI transaction transmission, which is currently used in a few existing DoD EDI applications (e.g., POPS and SPEDE), is incompatible with a general electronic mail approach. As soon as feasible, these prototypes and their successors should begin using electronic mail so that experience is gained with this method of DoD-vendor interaction.

### Data Volumes and Traffic

As DoD increasingly conducts business with external organizations in electronic form via EDI-formatted transactions, an obvious question arises regarding the network bandwidth required to support these transactions. Are the capacities of present and planned DoD networks and public WANs sufficient?

To create a very rough estimate of the data volumes involved, consider the following calculation (based on FY88 DoD procurement statistics):<sup>7</sup>

1. The total number of FY88 DoD procurement contract actions equals 14.7 million.
2. Although certainly not all of the above procurement actions are for well-defined items amenable to EDI, assume as a worst case that ALL those actions are handled by EDI.
3. Assume the number of EDI transactions generated (either from or to DoD) for each contract action equals 10 transactions.<sup>8</sup>

<sup>7</sup>With the expected future downsizing of portions of DoD, the FY88 statistics may in the 1990s decrease to a fraction of their current values, which does not change the conclusions reached in this approximate calculation.

<sup>8</sup>The 10 transactions might typically be accounted for as follows: (1) RFQ; (2,3,4) quotes from three firms; (5,6,7) award to one firm with information to other two; (8) shipment information from vendor; (9) confirmation from DoD; (10) vendor's invoice. We ignore possible functional acknowledgments at each of the above steps.

4. Assume the average number of characters needed to record the content per transaction equals 2,000 characters.
5. Assume, given parity checks and redundancy, an average of 10 bits per character.
6. Assume a multiplication factor for EDI formatting overhead doubles characters per transaction.
7. Therefore, the number of bits/year generated to handle the above EDI transactions is:

$$14.7\text{M} \times 10 \times 2\text{K} \times 10 \times 2 = 5.9 \times 10^{12} \text{ bits/year}$$

8. Assume these transactions are spread over 240 business days per year; therefore the average bits per day is:

25 billion bits/day—or, equivalently, 25 gigabits/day

A mature EDI system, perhaps 10 to 15 years from now, would actually generate at least several hundreds of times this volume because, for example, individual RFQs would be rebroadcast by VANs to hundreds of subscribers on the basis of their interest profiles.

Is data volume a problem? Given these estimates, no. DoD EDI data volumes will not begin to approach that volume for at least five years because of security requirements and other constraints discussed below. Within the next five years, most communication experts agree that gigabit-per-second data lines will be available throughout the country via fiberoptic links and special communication switches capable of handling high-density data traffic. The volume computed above amounts to 25 seconds of activity by one such data line, whereas the volume will in fact be shared by thousands of such lines.

One other factor bears on these volume and capacity estimates: in parallel with DoD activity toward greater use of EDI is a major DoD initiative, the CALS program, that seeks to promote the interchange of digital technical information for major system acquisitions, including both textual reports and data normally found on blueprints. Since CALS is still under development, we do not have reliable estimates on the data volumes to be expected from CALS transactions. However, given that major system acquisitions often result in large amounts of hard-copy documentation, that much of this information is technical and graphic, and that much of the data is sent repeatedly as thousands of engineering change orders are processed, critical design reviews are held, and so on, we expect that the total data volume aris-

ing from CALS transactions will be at least hundreds of times that from EDI. This will in turn provide a forcing function on the design and deployment of next-generation data networks, resulting in an available bandwidth of which EDI transactions will comprise only a small percentage.

### **Cost to DoD for EDI**

No accurate estimates are available on DoD's total investment to date in EDI or planned investments. Costs include those of the network and software infrastructure described in this section as well as the specific EDI applications. Within DoD, a considerable amount of the network and software infrastructure required for EDI is either in place (for example, the DDN) or being implemented through such programs as Livermore's IGP. To the extent that DoD networks, nodes, and gateways do not supply all needed capabilities, EDI transactions could at some future time use some of the facilities of the major government communications system procurement called FTS2000.

The DLA, with dozens of EDI projects under way, estimates that because in-house personnel have primarily been used, development work has cost about \$0.5 million, and Livermore's IGP might require \$2 to \$3 million over four to five years. The SPEDE prototype was again done mainly in house at a cost of about \$1 million, and the POPS prototype has cost about \$0.5 million. (The low cost is misleading because the developments were mainly performed as part of enhancements to other, related systems.) Altogether, a DLA spokesman estimated that EDI prototypes and developments may total about \$10 to \$12 million before a major cutover to widespread operational usage becomes possible. Because of obstacles and considerations primarily involving the assurance of the integrity and privacy of key EDI transactions, however, this estimate is probably low, so additional resources should be budgeted.

Because of many uncertainties and variables regarding how internal DoD communications costs are allocated among using offices and agencies, our remaining cost discussion concentrates only on *external* costs to DoD agencies incurred from using EDI—that is, costs paid by DoD to private industry in order to achieve widespread use of EDI in handling DoD logistics transactions.

Ongoing costs to DoD for using EDI depend on whether DoD uses its own WAN or a public WAN for its mailboxes and offers mailboxes on a DoD WAN to vendors. Consider two scenarios at opposite ends

of the cost spectrum. For each, we assume the data for DoD-originated transactions already exists within some DoD database (e.g., in MODELS format) and that translation software into standard X12 format is provided by a software package supplied by a DoD development project such as the Livermore intelligent gateway.

*Scenario 1.* DoD provides an electronic mailbox for each of its active suppliers or contractors within a private DoD WAN.<sup>9</sup> Given the configuration of this network, DoD will not have any additional costs to exchange transactions with vendors other than the internal costs of maintaining the WAN with its mailboxes. Each vendor mailbox will have a moderate amount of storage capacity but will not be considered a permanent archive in which vendors can store transaction records. With those assumptions, the external cost to DoD for EDI is essentially zero.

*Scenario 2.* DoD decides to use its private WAN only for DoD mailboxes and to provide mailboxes for its suppliers on commercial WANs. A very approximate, worst-case cost estimate can be derived from commercial EDI VAN cost schedules. For off-peak usage (which DoD computers can easily be programmed to handle), assume:<sup>10</sup>

- A fixed cost of \$25 per mailbox per month,
- A variable cost of \$0.40 per thousand characters sent and \$0.20 per thousand characters received; and
- A 45 percent discount for a large volume of transactions such as DoD would generate.

Therefore, assuming that *all* DoD EDI transactions were distributed commercially; that they were distributed approximately equally among messages sent and received (as a worst-case scenario); that *all* companies that have expressed interest in being a DoD supplier were provided mailboxes (say, 300,000); and that the very high earlier estimate of  $5.9 \times 10^{12}$  bits per year were transmitted, the total cost per year (assuming 10 bits/character) could be:

<sup>9</sup>As discussed above, some vendors will likely opt to use their own mailboxes on public WANS, but for this cost estimate we assume that all will use DoD-provided mailboxes.

<sup>10</sup>The cost structure given is from one company brochure. As such, it is most likely a "worst case" calculation given that DoD's EDI transaction business would certainly be competitively bid, with substantial competition expected among a number of major vendors of EDI communication and translation services.

$$\begin{aligned}
 &0.55 \times [ (300,000 \times \$25 \times 12) \\
 &\quad + (2.95 \times 10^8 \times \$0.40) \\
 &\quad + (2.95 \times 10^8 \times \$0.20) ] = \$147 \text{ million/year}
 \end{aligned}$$

or about \$1 per EDI transaction.<sup>11</sup>

This \$147 million annual cost might be split between DoD vendors and DoD using a variety of cost allocation approaches. (An example of a cost allocation strategy is given below.) We reiterate that this is a worst-case projection and that competitive bidding for this tremendous quantity of business would certainly lower the transaction cost. The lower bound for this scenario's cost would be zero, for the GSA recently negotiated a contract at *zero cost* to the government for information network services (the assumption being that if commercial sector transactions with the government were conducted using this network, revenue would accrue from other transactions initiated by private sector companies to obtain and analyze this data).

A more likely scenario, and one that would fall along the cost spectrum between those above, is that suggested above under the first objective in this section. DoD would provide "free" mailboxes on its WAN for vendors that so chose; others could pay for their own mailboxes on commercial WANs. In such a case, costs might be split between DoD and the vendors. We therefore estimate that DoD's actual external cost might well be half of the \$147 million total, or less than \$75 million per year. (Note, however, that this still assumes that *all* DoD procurement transactions are handled by EDI—an assumption that will only very gradually become valid.)

Despite the uncertainty regarding cost, it would appear that the development of an infrastructure for EDI is a requisite investment given trends in the private sector to move to EDI, DoD's commitment to electronic commerce, and potential gains in logistics. To keep costs from outstripping benefits in the early phases, EDI can be developed in modules in close connection with promising applications that are

<sup>11</sup>This estimate is somewhat lower than the \$1.23 cost per EDI transaction (or \$3.99 to send an average of 3.24 GBL copies to addressees) estimated in the DoD prototype test of EDI in transportation (see Heard and Ledder, 1987, p. E-20), but these higher transaction costs were due to the fact that transmissions were made during prime business hours; all data were transmitted to all addressees, not just the fields they needed; and no substantial volume discounts were available. If the transactions had been transmitted during off-peak times, the cost would have dropped 33 percent to \$0.82 per GBL copy; our estimate is therefore almost centered between the peak and off-peak rates given for this earlier test.

carefully designed and implemented to overcome the obstacles identified in Section IV. For example, as is being done now, the IGP can be developed and tested with current EDI applications and expanded as benefits warrant.<sup>12</sup> Similarly, the use of a private DoD or public WAN can be tested with vendor addressing and mailbox usage for vendors involved in this particular application.

### **PROVIDE AN ENVIRONMENT IN WHICH ELECTRONIC TOOLS CAN OPERATE EFFECTIVELY**

The second objective of DoD network and software support for EDI is to create an EDI environment in which the set of "tools" introduced in Section I ("broker" systems, broadcasting of information, electronic bulletin boards, databases, and "agent" programs) can be used to enhance logistics processes in the target areas. Electronic agents and brokering systems require no special considerations other than that transactions be in common electronic formats so that agents or broker programs can monitor and analyze them. Broadcast systems, too, are not so troublesome. If a DoD logistics function (probably a buying point) wants to use a private sector broadcasting system to advertise buys, it can use an appropriately secured electronic link to such a system, broadcasting the few transactions it chooses to.<sup>13</sup>

The use of bulletin boards and cross-vendor databases (e.g., of stock availability) pose some important network architecture questions, especially because in procurement it might be advantageous for DoD to share these tools with non-DoD buyers in order to tap a broader marketplace and ease vendors' efforts to do business with DoD (see Section III). It was also suggested in Section III that bulletin boards be available to not-yet-identified vendors for browsing and analysis. In bulletin boards, DoD would be sharing information on prospective buys. In cross-vendor databases of stock availability, DoD would not necessarily be sharing its own information<sup>14</sup> but would instead be accessing vendors' information.

<sup>12</sup>Conceivably, expansions could even be financed—in whole or in part—by savings achieved. The difficulty with this approach is that benefits are likely to accrue to different parts of DoD than those burdened with the costs. This mismatch between local costs and local benefits should not be permitted to stop developments that provide net benefits to DoD overall.

<sup>13</sup>If DoD set up its own broadcasting system, the considerations below regarding bulletin boards would apply. Of course, the security constraints discussed below may limit the extent of broadcast system use.

## Bulletin Boards

The objective of providing an environment conducive to effective use of electronic tools can be achieved through use of the electronic mail approach for EDI transactions, as described above. In this framework, any bulletin board can reside in some easily accessible WAN so that non-DoD buyers can post items as well and vendors known or unknown to DoD can easily access them. But this raises an important question: What is accessible enough? That is to say, where should these tools reside to be easily reached by vendors, known and unknown? (An additional question regarding security implications is addressed in a later subsection.)

For purposes of discussion, let us use a bulletin board tool described in Section III, an "electronic CBD." Unlike the hard-copy CBD, this medium could include the bulk of buys under \$25,000 as well as those over \$25,000. The CBD, or parts of it, may be combined with RFQs or RFPs for non-DoD buyers. To achieve one of the potential reductions in PALT enabled by an electronic CBD—e.g., faster access by interested vendors than that afforded by the current hard-copy CBD—the electronic one must be considered the "official" version; given an official electronic version, new and much shorter presolicitation and solicitation time limits should be stated in a revised FAR. (Hard-copy options will be discussed under the following objective.) Not only should the electronic CBD be at least as accessible as the hard-copy CBD, but vendors should be able to sort out what they are interested in much more easily owing to its electronic format.

This CBD could conceivably reside on a DoD WAN or a commercial WAN. To make it accessible to non-DoD vendors and to share it with non-DoD buyers (to whom, for security reasons, access to private DoD WAN networks may well be restricted), we recommend that it reside (with some exceptions) on commercial WANs, perhaps with a parallel version on a DoD WAN for all or part of the commercial WAN version. (In fact, the DoD WAN version could also include portions of the CBD that required greater security protection.) Assuming the most conservative and redundant approach of residence on both DoD and commercial WANs, this is how it might work. The CBD would be posted and continuously updated with electronic transactions in a searchable bulletin board on the DoD WAN accessible only to qualified DoD vendors (those with DoD mailboxes). It would be in two formats: X12 and human readable. It could be segmented by Federal

<sup>14</sup>Conceivably, DoD might use such databases to dispose of surplus stock. Given that this function does not directly affect the logistics pipeline, it is not considered here.

Supply Class (FSC), by region, or in other ways consistent with industry conventions. DoD vendors could browse and sort through it, downloading portions of interest to them to their own computers.

To reach unidentified vendors, the CBD could be posted similarly in one or more commercial WANs. This CBD could be managed by DoD or, preferably, by one or more private firms under conditions that met DoD's accessibility criteria, including fees charged to vendors. DoD contract terms might stipulate that parts of the CBD be combined with a bulletin board used by non-DoD buyers. Entrepreneurs could then provide value-added services using this version of the CBD, including combining the CBD information with other buyers' information or running electronic agents to screen for "hot" leads, much as private firms now do with the electronic version they buy from the Department of Commerce.

This arrangement would differ from the current way the CBD is available electronically in two important ways. First, the "master" electronic copies of the CBD on commercial WANs would be governed by strict DoD contractual terms of comprehensiveness, accessibility, and accuracy. This would enable this electronic version to meet the FAR conditions of allowing all interested and qualified vendors a reasonable chance to learn about and pursue DoD work. Second, the CBD would include information needed to initiate electronic transactions to pursue the business listed. For non-DoD vendors, this would mean a qualification process. If this process were simple, as is the case for many small buys, it could be handled electronically. More complicated processes would "fall out" into a nonelectronic process when necessary.

### **Cross-Vendor Databases**

A cross-vendor database used by DoD would in almost all cases need to reside on a commercial WAN. Electronic (and even automatic) links to it could pass through the IGP (for interconnection and any necessary translations). For example, a DoD inventory manager could direct electronic queries of stock availability via the gateway to the database and receive a response back. If warranted, an RFQ could be routed to a vendor with available stock, and the process could continue as a normal EDI transaction exchange—except that the vendor might be accessed via the cross-vendor databases' communications network.

### **ENSURE THE PRIVACY, SECURITY, AND INTEGRITY OF EDI DATA**

Widespread use of EDI for DoD logistics transactions will result—in the not-too-distant future—in the transmission of hundreds of thousands of additional electronic messages throughout the country each day. Unlike funds transfer transactions between banks, these messages will be routed literally to hundreds of thousands of businesses. Furthermore, the transactions, both individually and in the aggregate, will contain information about DoD procurement and resupply quantities, bidding and contract dollar amounts, transportation status reports, and other logistics information providing a detailed overview from which force strengths, expected arrival times of ships in ports, costs and suppliers of weapons components, preparations for surges in usage or demand, and a variety of other intelligence might be gleaned. From the vendor's point of view, too, some of these EDI transactions might contain company-sensitive data on bid dollar amounts, promised shipment schedules, and other data that must be kept private and inaccessible to competitors.

The transactions mentioned above are already occurring today via U.S. mail, air couriers, some electronic messages, and a variety of other modes. Why, then, are security and privacy concerns any different if the bulk of DoD logistics transactions shift to EDI over electronic networks? The answer is that having all these transactions in a uniform, electronic, machine-readable format—and possibly collected in only a few locations (such as centralized databases acting as electronic bulletin boards and mailbox repositories)—creates the possibility of concerted threats against the system using computers to aggregate, modify, decode, and report on some or all of the transactions.

Balancing these concerns, however, is a need for reasonableness in dealing with the security, privacy, and integrity of data. We should make distinctions regarding the sensitivity and risks associated with types of data and transactions, types of commodities or services involved, dollar amounts of transactions, and other characteristics that differentiate EDI transactions. Strategies for addressing each risk should match the level and type of risk and should rarely be applied across all EDI transactions. DoD should also take care to apply such techniques as encryption, which might adversely affect small businesses, *only* when alternative methods not requiring complex policies

and procedures by suppliers will not suffice. This point was well stated in a recent speech:

Using the same technologies, products, and procedures currently used to protect classified data and applying them to the protection of all the rest of our data would be grossly expensive and, ultimately, counterproductive. . . . [T]he problem of protecting *not* classified data [is] much harder than the simple problem of protecting classified data. We must do more, with fewer resources, for more data, in ambiguous environments, without the fallback position of physical security.<sup>15</sup>

As discussed above under the objective concerning use of electronic tools, some procurement information if aggregated and analyzed may be assigned to the new DoD category mandated by the Computer Security Act of 1987: "unclassified but sensitive" (although we are certainly not recommending that rather drastic step be taken without very careful study). If this occurs, such transactions would require special handling, perhaps via a separate DoD WAN. At that point, security and privacy concerns could impact literally hundreds of thousands of U.S. business establishments. It is one thing for sophisticated prime contractors to handle electronic sensitive material with established, approved procedures but quite another for a small business supplier of bearings or brackets to do so.

A threat assessment is the starting point for understanding the privacy, security, and integrity requirements involved in widespread DoD adoption of EDI. From the perceived threat, risks can be assigned, alternative techniques can be identified to address them, and risks can be weighed against benefits. It appears that the main categories of threats to DoD EDI are:

1. *Defense security related:*

- Foreign intelligence gathering regarding troop strengths and locations, plans, movements, readiness, and the like from the content or traffic patterns of EDI transactions; or
- Sabotage of DoD logistics by destruction or incapacitation of centralized electronic records (by electronic means such as "worms" or "viruses" or by physical means).

2. *Accuracy, integrity, and completeness of transactions:*

- Fraud and abuse from access to, or modification of, financial information contained in the EDI transactions; or

<sup>15</sup>Bocast, 1990.

- Accidental loss or misrouting of transactions.

### 3. *Privacy and protection of business confidential data:*

- Lack of trust of the privacy protection features of the system by commercial sector firms for their sensitive data, such as proposals in response to RFPs.

All three areas are of concern. Below we discuss measures relevant to ensuring that the risks associated with these threat areas are brought down to acceptable levels.

## Defense Security Threats

As mentioned above, valuable information about defense movements, strengths, and readiness can be obtained both from the content of EDI-related messages and from traffic analysis concerned with the amount and destinations of such messages. Traditional defense security measures are relevant to these threats, including physical security (e.g., denying physical access to key facilities), procedural security (e.g., password protection of remote connections into information systems), and communications security (e.g., encryption of certain fields within transactions).

Our discussion of defense security threats centers on the aggregation and dissemination of unclassified data, as there are measures in place for telecommunications security equipment, devices, techniques, and services to handle the security of contractor telecommunications with respect to DoD classified information.<sup>16</sup>

We consider two topics in some detail: encryption and "sensitive but unclassified" information. Encryption raises the following issues:

- The definition of the current X12 standard allows for encryption of the entire transaction or a group of transactions (excluding data elements representing the transaction type and the sender and recipient) but not of individual data elements (fields) within the transaction. It is unclear whether DoD requires individual field encryption.
- What encryption mechanism or combination of mechanisms should be used: the Data Encryption Standard (DES),<sup>17</sup>

<sup>16</sup>See, for example, 252.204-7008 of the DoD FAR Supplement (DFARS), 1989.

<sup>17</sup>The Data Encryption Standard is the basis for several ANSI encryption standards. For the background and status of this standard, see Smid and Branstad, 1988.

Public Key Encryption (PKE) schemes, or combinations of these?

- Currently there are U.S. export regulations preventing the dissemination of most encryption schemes, including DES and PKE, in devices sold or taken overseas to firms outside U.S. control. (This is in spite of the fact that both schemes have been published and are broadly known and available throughout the world.) Major U.S. firms, with their increasing global interconnections, may well be unwilling to use one security scheme for U.S. DoD EDI transactions and a wholly different scheme and set of procedures for their international electronic transactions.
- How should a handling scheme required by encryption be totally automated so that individual businesses need not adhere to any special procedures to ensure the security of the system?

A possible reasonable alternative to the apparent need for small businesses to handle encryption keys should be noted: DoD private networks such as AUTODIN allow "almost end-to-end encryption" by encrypting transmission lines. A small business could dial a nearby gateway into AUTODIN or its successors with a local (unencrypted) phone call and then use the defense network to complete the call to a remote DoD electronic mailbox or bulletin board. The only portion of the link that would be unencrypted would be the local phone call; all the rest of the transaction processing would be within a "security boundary" established by DoD for systems over which it has direct control. That level of risk could well be considered as acceptable. These local calls would be distributed around the nation such that they would not provide a central source of important logistics information. Since all the encryption is handled within AUTODIN, no individual encryption of EDI fields or messages by the end user would be required. Again, the current protection criterion might apply: the level of protection for routine transactions is as good as that under current procedures.

Another approach that may help keep security considerations within reasonable bounds is for DoD to differentiate which *types* of information for all transactions and which *sets* of buys should be omitted from any electronic bulletin board and whether more secure subboards could be used where needed to achieve lesser benefits but reduce unwarranted risks. Types of information that might be excluded would be any information revealing the intended user. Priority could also be omitted. Needed details could be provided to those quoting on

a particular announcement. A two-step process could even be used for certain transactions where the bulletin board would include enough information for a qualified vendor to sort out interests, but where the remaining details would be sent only to a qualified vendor who identified himself as interested.

We do not underestimate the security challenges posed by this issue. Third-party information providers have been grappling with a similar and at least as difficult problem regarding electronic access to various federal government databases such as the National Technical Information Service (NTIS). A good description of the issues involved may be found in Bollinger and Ellingen (1987). In that paper, it is concluded that:

the extraction of additional, possibly sensitive, information from the masses of otherwise unclassified online data by sophisticated software—aggregate sensitivity—makes the control of commercial online information impractical unless all research against it is thoroughly monitored. Broadly speaking, attempts to establish political controls over technological advances are usually doomed to failure either by their direct defiance and circumvention, or their own stifling effect over time on the very economies they seek to protect.

How much of the sensitive data that could be derived from DoD bulletin boards is already derivable from other means? We suggest that the answer is a considerable amount and further suggest that security restraints not be placed on the distribution of electronic procurement data that are more stringent than those currently in effect for other sources of procurement information.

It is likely that some set of defense EDI transactions will be categorized as "sensitive but unclassified." Guidance and standards for sensitive but unclassified data fall under the purview of the National Institute for Standards and Technology (NIST). NIST, however, has not yet taken a position regarding the appropriate handling of this data or even regarding the approach to resolving the question. Two of the contending approaches might be (1) the development of a civilian counterpart to the DoD "Orange Book"<sup>18</sup> describing criteria for systems handling this new category of information; or (2) the development of a set of appropriate Federal Information Processing Standards (FIPS). Whatever strategy is chosen, years of work lie ahead. Standards and criteria must be created, test procedures de-

<sup>18</sup>DoD, 1983.

veloped, meetings and reviews held for concerned parties, and documents distributed, revised, and published. To our knowledge, this process is starting from near ground-zero because the threat perception in the nonclassified world remains poorly defined and because there is no agreement as to the safeguards required to fend off whatever the threat turns out to be.

A current project, Protection of Logistics' Unclassified/Sensitive Systems (PLUS), sponsored by OASD(P&L), is exploring the adoption of PKE techniques for the protection of CALS and EDI logistics data, with technical guidance from NIST and the National Security Agency (NSA).<sup>19</sup> Results from this project should help resolve some of the defense security questions discussed above. However, other techniques and approaches could minimize the need for encryption while ensuring privacy, accuracy, integrity, and completeness of transactions. They are discussed below.

### Threats to Privacy, Accuracy, Integrity, and Completeness

The above discussion dealt with the specific topic of protection of defense secrets, primarily through the use of encryption. However, there is a much larger problem in developing a DoD-wide EDI system: ensuring the privacy, accuracy, integrity, and completeness of each of the hundreds of thousands of transactions within the system, at least to the level currently attained. Consider the following set of interrelated factors:

- "The system" to be protected involves thousands of individual computers, data links, databases, and network nodes. Within this system, we must let individual small businesses input data into protected databases and protected systems; we must let businesses do a certain amount of browsing in protected databases; we must ensure that the sophisticated connectees cannot cause the system to crash or gain unauthorized access to it; and we must transmit selected information out from the protected databases and systems.
- Every transmission must securely identify its originator and recipient. It might be necessary to generate a "return receipt"<sup>20</sup> for DoD EDI transmissions and a similar "certi-

<sup>19</sup>Hampel, 1990.

<sup>20</sup>Provisions exist within the X12 format for requesting acknowledgment of an interchange and for generating a functional acknowledgment.

fication of decision" feature that lets vendors know who made what decision about them and when. Such facilities are an excellent guard against system failures, providing assurance that EDI transactions have in fact gotten through to the intended recipient. They also help resolve any questions or disputes raised by suppliers or by the government itself. All such procedures must be carried out with legally binding audit trails that function automatically and that also have extraordinarily high security against modification, destruction, or unauthorized inspection.<sup>21</sup>

- There is a security requirement to be addressed *within* DoD. The temptation of the insider to use the system to funnel business to preferred friends will be *strong* in an EDI world. There must be concomitant safeguards, audits, and oversight to monitor—and hence to constrain—the actions of all insiders.
- The integrity of many transactions must be (verifiably) such that contractual obligations can be carried out without requiring that a parallel, hard-copy "wet" signature be sent. The safeguards and procedures must satisfy court tests of their authenticity and reliability. In addition, they should protect defense employees against inappropriate legal challenges.

*No one* has handled the security problem in the fullness that DoD EDI will experience it. In the commercial world, much of the concern would be ignored or dealt with summarily because a company is not in the public eye, is not subject to the same legislation about how contracts are let, does not have to deal with so many diverse vendors, and so forth. In contrast, DoD cannot be cavalier about the requirement because it is in the public eye and is subject to tight examinations and oversight. We conclude that it must perform the security task fully and properly while maintaining conditions of openness—a combination that is without precedent. Add to this the likely classification of some EDI data as sensitive but unclassified (discussed earlier), whose appropriate handling is not even defined and whose purview is within a wholly different agency than that of other classified data. The result is a complex, time-consuming task from which initial solutions suitable to large-scale handling of EDI transactions cannot be expected for at least five to eight years.

<sup>21</sup>A useful discussion of audit procedures appropriate for EDI systems is contained in Hansen and Hill, 1989.

Security, privacy, integrity, and audit trails for procurement transactions may actually *increase* owing to techniques applicable to electronic media for transactions that are often now handled by telephone. We again caution, however, against attempting to attain perfect security, especially by overencryption of data. Emphasis should be placed on totally automatic procedures invisible to the small businesses that are the great majority of DoD's suppliers; procedures such as effective electronic audit trails to track who has accessed or altered which information can provide much of the needed protection while not inconveniencing suppliers. Audit trails are also vital to establishing the evidentiary support needed for any court challenges to procurement awards and decisions.

The interested reader can find additional discussion of security requirements, use of IGP's, and networking options in a recent report on CALS telecommunications.<sup>22</sup> Although specialized to CALS requirements, many of the same considerations also apply to EDI data transmission.

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<sup>22</sup>Doby, 1989

## Appendix

### ANSI X12 EDI TRANSACTION SETS

Below are the approved ANSI X12 EDI transaction sets as of October 1990. Several other transaction sets were under development or in the process of being approved through the ANSI committee process.

ANSI#	Ref.#	Transaction Name
810	X12.2	Invoice
819	X12.43	Operating Expense Statement
820	X12.4	Payment Order/Remittance Advice
822	X12.25	Customer Account Analysis
823	X12.38	Lockbox
830	X12.14	Planning Schedule/Material Release
832	X12.13	Price Sales Catalog
840	X12.7	Request for Quotation (RFQ)
843	X12.8	Response to Request for Quotation
844	X12.26	Product Transfer Account Adjustment
845	X12.27	Price Authorization Acknowledgment/Status
846	X12.28	Inventory Inquiry/Advice
849	X12.50	Response to Product Transfer Account Adjustment
850	X12.1	Purchase Order (P.O.)
855	X12.9	P.O. Acknowledgment
856	X12.10	Ship Notice/Manifest
858	X12.18	Shipment Information
860	X12.15	P.O. Change
861	X12.12	Receiving Advice
862	X12.37	Shipping Schedule
863	X12.41	Report of Test Results
865	X12.16	P.O. Change Acknowledgment
867	X12.33	Product Transfer and Resale Report
869	X12.11	Order Status Inquiry
870	X12.23	Order Status Report
997	X12.20	Functional Acknowledgment

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